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A STRATEGY FOR ACCELERATED SELECTION AND RELEASE OF ADVANCED-GENERATION EUCALYPT SPECIES HYBRIDS*

C.S. VENKATESH**

Genetics Division, Kerala Forest Research Institute,
Peechi, Kerala

Introduction

As quick-growing exotics in many parts of the tropical world, the Australian Eucalypts have few rivals. They can grow on a wide range of sites needing little attention, and are capable of producing mean annual increments of 10 m^3/ha/annum or more, of fuelwood, pulpwood and small-sized timber for poles and posts, in short, 8–12 year rotations. Many of them coppice well and can give at least three successive crops before replanting by seed.

In recent years, artificial or natural interspecific hybirds displaying very strong heterosis for quantitative characters were reported within this large genus (Venkatesh and Sharma, 1976, 1979). The present paper describes the case example of the strategy adopted for rapid evaluation, selection and practical utilization of advanced-generation hybrids of two promising reciprocal interspecific crosses between *E. tereticornis* Sm. and *E. camaldulensis* Dehnh. two of the most widely grown eucalypt species in the world today.

Experimental methods

In pilot field trials in a single location at Dehra Dun (Lat. 30°30′40″ N; Alt. 640 m; rainfall 2000 mm, mostly in summer), F_1 hybrids of the controlled cross FRI-4 (*E. tereticornis* tree No. 14 × *E. camaldulensis* tree No. 2) and the natural cross FRI-5 (*E. camaldulensis* tree No. 2 × *E. tereticornis* tree No. 1) displayed heterotic superiority not only in height and diameter growth but also in many reproductive features such as flowering precocity, flower and seed productivity, seed-weight, germinability and germination vigour.

In one experiment at Dehra Dun, open-pollinated F_2 seed from seven randomly chosen F_1 hybrids of each class were sown separately and a half-sib F_2 progeny trial established in the same experimental area where the parental F_1 hybrids had been planted earlier in 1972. The seeds had been sown in earthenware pots, pricked out into polythene container bags when three months old and transplanted into the field during the rains in

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**Currently on Foreign Service deputation from the F.R.I. and Colleges, Dehra Dun.

July, 1977, according to a randomized blocks design with 16-tree family plots replicated thrice and uniformly spaced at 2×2 m.

For multilocation trials outside Dehra Dun, open-pollinated F_2 seed from a number of F_1 hybrids were bulked together class-wise and distributed as breeder or nucleus seed to State Forest Departments, Forest Corporations and private individuals, for raising as isolated block plantations, at 2×2 m planting density. Block size and design were however left to the convenience of actual growers.

Results

In Tables 1 and 2 are given the mean values for height and diameter at age 2, of the seven open-pollinated families each of FRI-4 and FRI-5, at Dehra Dun. It can be seen that the differences between families was significant but only at a low level (5%). Except in one case, families that were superior in height were also those that had superior average diameters. FRI-4 families 99, 104 and FRI-5 families 13, 1652 and 1763 were definitely inferior in both height and diameter at this age. However, the F_1 hybrid parents from which these inferior families originated were individually much superior in both height and diameter than parents of the superior families. This emphasises the importance of progeny testing and selection in advanced generations. Even within the inferior families there were a few hybrids which were individually well above the family and class mean in regard to height and diameter.

In the family trial at Dehra Dun, differences in average height and diameter between FRI-4 and FRI-5 were not significant at 5% level. But in other trials in the same state, FRI-5 is reportedly performing better than FRI-4. In Adirapally range, Kerala in the extreme south of the country, FRI-4 and FRI-5 were again equally superior and practically indistinguishable from each other. Within only eighteen months of sowing, average height in this trial was 8 m and average diameter at breast height was 5-6 cm. Even within the large 1 ha plots used in this particular trial, surprisingly very little variation in height and diameter was noticeable. Presumably this is an exceptionally good site equally favourable to both the hybrid classes, and to all the recombinant genotypes within each one of them, thus accounting for the observed luxurious and uniform growth of practically all individuals.

The above observations support in retrospect the soundness of the strategy adopted of: (1) testing both classes of hybrids under a variety of site conditions in different environments; (2) using for this purpose bulked F_2 seeds from a number of F_1 hybrid parents rather than from only a few phenotypically outstanding ones.

Conclusions

The following considerations guided the strategy adopted here for concurrent production and recurrent selection in advanced generations :

(1) *De novo* production of F_1 seed on large scale required for multilocation testing would have involved much time, effort and perhaps cost also. F_2 seed of high fertility was, on the other hand, readily and cheaply available in large quantities as a "by-product" from the F_1 hybrids.

Tabel 1

Ranking of seven FRI-4 families at age 2 at Dehra Dun

Parameter	Family identity							Significance level	Bar diagram
	16	60	61	66	99	104	150		
Height (m)	2.53	2.47	2.72	2.43	2.16	2.32	2.30	5%	61 16 60 66 104 150 99
Diameter (cm)	2.86	2.76	2.85	2.73	2.50	2.59	2.74	5%	16 61 60 150 66 104 99

Table 2

Ranking of seven FRI-5 families at age 2 at Dehra Dun

Parameter	Family identity							Significance level	Bar diagram
	12	13	96	1643	1652	1659	1763		
Height (m)	2.41	2.08	2.40	2.61	2.14	2.35	2.16	5%	1643 12 96 1659 1763 1652 13
Diameter (cm)	2.71	2.36	2.77	2.67	2.40	2.83	2.51	5%	1659 96 12 1643 1763 1652 13

(2) As exemplified by Pitch-loblolly pine hybrids in Korea, heterosis in interspecific tree hybrids is not confined to F_1 alone, but persists in advanced generations also.

(3) It is well known that heterosis can change with the environment and planting density. It may be more pronounced in intermediate, that is, hybrid habitats. Further, due to genotype × environment interaction differences, F_2 recombinants that were outstanding let us say at Dahra Dun, need not prove to be so in other locations where other recombinants may perform better. In other words, multilocation assessment helps in picking out "winner" recombinants best suited for each locality.

(4) Unlike traditional agricultural plants, forest trees cannot be provided by man with optimal conditions for growth (Allard, 1960). They must therefore possess wide ecological amplitudes and broad adaptabilities to be able to fend for themselves under more or less natural conditions. In this context, a large F_2 population will definitely be more advantageous than an F_1 since it exhibits an enormous amount of genetic diversity resulting from segregation and recombination. Natural selection may be expected to automatically isolate from such a population, those recombinant genotypes that perform best under a prevailing site condition. These can then from the starting point for both commercial exploitation of F_2 heterosis through vegetative propagation of multiclonal growing stock as well as for raising through seed F_3 plantations for recurrent selection and further generation advancement.

In the long term, as specifically suggested for eucalypts by Wright (1976), by recurrent selection in the F_2, F_3 and later generations, it will be possible to produce stabilized segregate hybrid varieties best adapted to particular planting sites. In the meantime, commercial use of intermediate generation hybrids will go on especially through vegetative propagation. It may be recalled in this context that recently mass clonal propagation of natural *E. grandis* hybrids has been successfully achieved in Brazil (D.G. Nikles, personal communication).

Figure 1 illustrates the entire strategy proposed here, in digrammatic form.

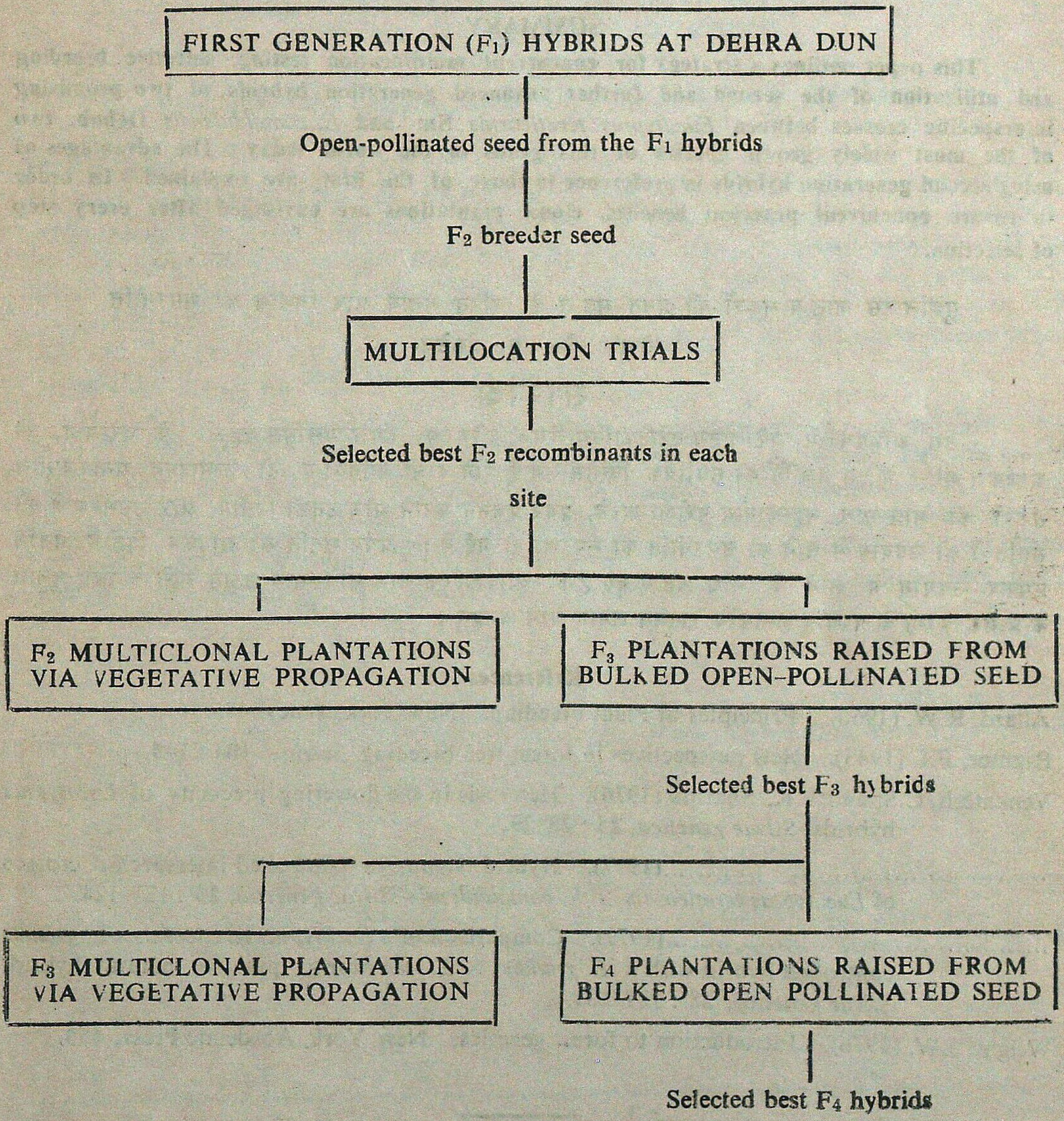
As reported earlier, (Venkatesh and Sharma, 1976) F_1 hybrids of both FRI-4 and FRI-5 were precocious flowering. The same also later proved true of the F_2s. Such early reproductive maturity enables rapid generation advancement. Thus, it was possible to raise at Dehra Dun three generations of hybrids within only nine years.

After selection of the best F_2 hybrid recombinants, the first cycle multilocation trial in each area could be converted into and managed as a progeny-tested, "elite" seedling seed orchard to give repeated crops of F_3 seed and simultaneously also serve as source material for multiclonal F_2 propagules for planting in the same part of a state, where the particular trial had been laid.

The strategy proposed here was modelled after the concurrent trial-cum-production method originally suggested by Righter (1946) for newly developed forest tree varieties. In the present case it serves the dual purpose of accelerated recurrent selection and generation advancement allowing at the same time for rapid practical application at every step.

Finally, it must be emphasised that in forestry, any tree improvement strategy that can lead to quick practical benefits is to be preferred even if it may not be the perfect one.

Fig. 1



Diagrammatic representation of the strategy adopted.

Acknowledgement

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SUMMARY

This paper outlines a strategy for concurrent multilocation testing, selective breeding and utilization of the second and further advanced generation hybrids of two promising interspecific crosses between *Eucalyptus tereticornis* Sm. and *E. camaldulensis* Dehnh. two of the most widely grown species of this genus in the world today. The advantages of using second generation hybrids in preference to those of the first, are explained. In order to ensure concurrent practical benefits, clonal plantations are envisaged after every step of selection.

युकेलिप्टस जातीय संकरों की प्रगत संतति के त्वरित चुनाव और विकास की समरनीति

लेखक सी० एस० वेंकटेश

सारांश

इस अभिपत्र में *युकेलिप्टस टेरेटिकार्निस* स्मि० और यु० *कैमेलड्यूलेंसिस* डेह्नं० के दरम्यान, जो आजकल संसार में इस प्रजाति की सर्वाधिक विस्तृत उगाई जाने वाली जातियां हैं, दो उत्साहप्रद अन्तरजातीय संकरों की साथ-साथ बहुस्थानीय परीक्षा करने, प्रवर प्रजनन कराने और उनकी द्वितीय और उससे आगे की संततियों को उपयोग में लाने की समरनीति की रूपरेखा दी गई है। प्रथम संतति को छोड़कर द्वितीय संतति प्रसंकर उपयोग में लाने के लाभ बताए गए हैं। व्यावहारिक लाभ साथ-साथ उठाते रहने के लिए चुनाव के प्रत्येक चरण के पश्चात् कृन्तकीय रोपवन लगाए जाने चाहिएं।

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LITTER PRODUCTION AND NUTRIENT RETURN IN *EUCALYPTUS* HYBRID PLANTATIONS

M. George
Forest Soil-cum-Vegetation Survey, Forest Research Centre, Coimbatore

Introduction

Green plants are the only primary producers of organic matter and potential energy through the process of photosynthesis on which all forms of life are dependent. Some of these primary organic materials are used for various metabolic activities, and the rest accumulated in the plant body. A substantial portion of the accumulated nutrients in the plant biomass is returned to the soil through litter fall and thus the study of quantitative aspect of litter production is important as it remains a major pathway for both energy and nutrient transfer in forest ecosystems.

In India, a large area of land is being planted with fast growing, short rotation crops mainly of *Eucalyptus* hybrid. However, it is not yet known as to the manner and magnitude with which the species affects the soil, and little is known about the amount of nutrients uptake and that returned to the soil through litter fall. Very few studies have been carried out in this respect mainly in sal (*Shorea robusta*), teak (*Tectona grandis*) and chir (*Pinus roxburghii*) plantations (Puri, 1953; Seth, *et al.*, 1963; Singh, 1968, 1969; Srivastava, *et al.*, 1972; and Subba Rao, *et al.*, 1972).

Study site

Studies on litter production and return of nutrients through litter fall were carried out for one year in three *Eucalyptus* hybrid plantations of East Dehra Dun Forest Division of Uttar Pradesh. Basic data on these three plantations is given in Table 1.

Table 1

Basic data on three Eucalyptus hybrid plantations

Age (Years)	Average D.B.H. (cm)	Average height (m)	No. of trees/ha	No. of litter plots	Rainfall (mm)	Soil type
5	11.1	14.64	1167	7	2000	Sand to
7	9.4	13.59	1167	7	2000	clay loam
10	14.4	19.00	1133	5	2000	

Materials and methods

Five to seven permanent litter plots of size 10 m × 10 m were laid out at random in each of the three plantations. All the trees in the plots were numbered and periodical litter collections were made from the litter plots for one complete year. Leaves, twigs and bark litter were collected separately and weighed in the field. Samples were brought to

the laboratory for dry weight estimation and chemical analysis using standard methods. Nitrogen was estimated by Kjeldhal's method, phosphorus by colorimeter and potassium and calcium by a Flame Photometer. Magnesium was precipitated as magnesium ammonium phosphate and titrated against standard NaOH (Loomis and Shull, 1937; Vogel, 1961).

Result and discussion

The estimated annual litter production per hectare basis is shown in Table 2 along with percentage of each component to the total litter.

Table 2

Litter production in Eucalyptus hybrid plantations

Age (Years)	Leaf		Twig		Bark		Total
	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha
5	2567	76.0	647	19.2	163	4.8	3377
7	2511	66.1	897	23.6	393	10.3	3801
10	4642	74.8	969	15.6	596	9.6	6207

Considering these three plantations individually a total of 3377, 3801 and 6207 kg/ha of litter is produced at ages 5, 7 and 10 years respectively indicating the effect of age. Ten year old plantation is producing almost double the amount of litter than that of 5 year old plantation with almost the same density while there is only a little difference between litter production at age 5 and 7 years. Of the total litter, the contribution of various components in there three plantations varies. Leaf litter contributes between 66% to 76% of the total litter; twigs between 16% to 24% and bark between 5% to 10%. There is no consistancy as to the percentage contribution of each component with age in three plantations, i.e., the highest contribution of leaf litter (76%) is at age 5, while highest twig and bark contribution (23.6% and 10.3%) is at age 7. The contribution of leaf litter as kg/ha varied from 2567 (5 years) to 4642 (10 years); leaf litter having almost doubled with double the age. Twig litter varied from 647 kg/ha (age 5 years) to 969 kg/ha (age 10 years) showing an increase of 1½ times with the age. The contribution of bark litter increased by more than 3 times from age 5 to 10 years, i.e., from 163 kg/ha (age 5 years) to 596 kg/ha (age 10 years). Leaf litter, therefore, contributed the bulk of the litter fall followed by twigs and bark.

The present investigation also indicates that leaf litter constitutes 93.8%, 87.8% and 68.2% of standing leaf weight at 10, 7 and 5 years respectively. Similarly the twig litter constitutes 5.1%, 11.2% and 8.8% of the standing branch and twig weight and bark litter constitutes 4.3%, 6.2% and 1.7% of the standing bark weight respectively in these plantations (George, 1977).

Annual litter production in different aged, plantations of *E. tereticornis* was estimated by Singh (1975). The total litter produced by these plantations as kg/ha was of the order of 2,330, 3,090, 4,500, 5,100 and 5,420 at age 5, 6, 7, 8 and 9 years respectively. Of the

total litter, leaf and non-leaf contribution as kg/ha for successive ages respectively was 1,800, (77%) and 530 (23%), 2,300 (74%) and 790 (26%), 3,500 (78%) and 1,000 (22%), 3,800 (75%) and 1,300 (25%) and 4,000 (74%) and 1,420 (26%). Bray and Gorham (1964) reviewing world literature on litter production reported that *E. regnans* pole forest produced a total litter of 6,900 kg/ha of which leaf litter contributed 3,600 kg/ha (52%) and non-leaf litter 3,300 kg/ha (48%). Similarly *E. marginata* virgin forest, *E. marginata* pole forest and *E. diversicolor* virgin forest produced a total litter of 2,400 kg/ha, 3,100 kg/ha and 5,700 kg/ha respectively. The leaf litter and non-leaf litter contribution for the three forests respectively was 1,200 kg/ha (50%) and 1,200 kg/ha (50%); 2,000 kg/ha (65%) and 1,100 kg/ha (35%) and 2,800 kg/ha (49%) and 2,900 kg/ha (51%).

In view of these studies the present investigation reveals that *Eucalyptus* hybrid produces more litter when compared with some other species of this genus. This may be due to the fact that *Eucalyptus* hybrid being fast growing than the above species, it produces more litter, as more the fast growing species is, the more litter it would produce (Penfold and Willis, 1961). With regard to the percentage contribution of different litter components in the total litter, the results obtained in the present study are in agreement with that of Singh (1975) and Bray and Gorham (1964) in that, the leaf litter contributed the major portion. Similar results were also obtained by Seth *et al.*, (1963), Misra (1969), Srivastava *et al.*, (1972) and Subba Rao *et al.*, (1972).

Bray and Gorham (1964) have given an exhaustive account of the litter production in the forests of the world. The data collected have been grouped under four major climatic zones, i.e., Equatorial, Warm temperate, Cool temperate and Arctic alpine. It was observed that the Equatorial forests produced the maximum amount of total litter (10,900 kg/ha) followed by Warm temperate (5,500 kg/ha), Cool temperate (3,500 kg/ha) and Arctic alpine (1,000 kg/ha). The authors have also reported that of the total litter, leaf litter contributed the major portion 62% in Equatorial forests and 65% in Warm temperate forests. This percentage contribution of leaf litter is in general agreement with that of the present study.

Nutrient return

Results of the chemical analysis of litter samples from these three plantations for N, P, K, Ca and Mg are shown in Table 3.

Considering the nutrients in the various litter components at different ages the concentration of all the nutrients was highest in the leaf litter followed by twigs and bark, except for Mg which showd a higher concentration in bark than in leaves and twigs. The concentration of nutrients in all the litter components at all the three ages decreases as Ca, N, K, Mg and P; the highest concentration being that of Ca and N and lowest that of P. The concentration of Ca and N were 18 and 17 times, 20 and 7 times and 20 and 8 times more than P respectively for leaf, twig and bark litter in 10 year old plantations. Ca and N concentration in 7 year old plantation was 20 and 18 times, 37 and 11 times and 24 and 10 times more than P for leaf, twig and bark litter respectively. Almost the same trend is exhibited by the 5 year old plantation also.

Table 3

Nutrient concentration in litter (% oven dry weight)

Age (Years)	Litter	Ca	N	K	Mg	P
5	Leaf	1.25	1.06	0.51	0.15	0.05
	Twig	1.06	0.32	0.23	0.12	0.04
	Bark	0.82	0.32	0.26	0.17	0.02
7	Leaf	1.20	1.11	0.56	0.17	0.06
	Twig	1.10	0.34	0.28	0.11	0.05
	Bark	0.71	0.31	0.22	0.20	0.03
10	Leaf	1.27	1.16	0.56	0.15	0.07
	Twig	1.00	0.35	0.30	0.12	0.05
	Bark	0.78	0.33	0.28	0.19	0.04

There is considerable variation in the nutrient content of leaves, twigs and bark of all the three plantations but the proporation by which a particular nutrient varies in these three litter components at all the three ages is almost the same. For example the percentage composition of Ca, N, K, Mg and P in the leaf litter is generally 1.1 and 1.6 times, 3.3 and 3.3 times, 2 and 2.2 times, 1.4 and 0.8 times and 1.5 and 2.1 times, that of twigs and bark respectively. Though the percentage composition of various nutrients in different litter coponents showed considerable variation in all the three plantations, the concentration of a particular nutrient for a particular component from these three plantations exhibited very little difference which may not be significant. It therfore, follows that the concentration of nutrients in the various litter components in this species is almost the same at all the ages (independent of age) at least for the ages that have been studied.

The total amount of nutrients returned to the soil through litter fall in one year (kg/ha) in these three plantations is shown in Table 4, which also indicates the percentage of different nutrients contributed by various components.

It will be observed that the total annual return of nutrients in all the three plantations is highest for Ca (73 2, 42.8 and 40.2 kg/ha respectively for 10, 7 and 5 years ages) followed by N, K, Mg and lowest for P (3.9, 1.9 and 1.65 kg/ha). The same trend is observed for nutrients returned through individual litter components for all the three ages. The maximum amount of all nutrients is returned through leaf litter and lowest through bark.

Comparing the return of nutrients on a unit area basis between these plantations it is observed that the return of nutrients in 10 years old plantation is almost double that of 5 and 7 years old plantations; the nutrients return (all nutrients) in 5 and 7 years old plantations being almost the same. As the density of these plantations is the same this reflects the effect of age and consequently of the amount of litter produced (Table 2).

Table 4

Nutrient return through litter fall

Age (Years)	Litter	Ca		N		K		Mg		P	
		Kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
5	Leaf	32.1	79.9	27.2	91.3	13.1	87.3	3.9	78.0	1.3	79.8
	Twig	6.8	16.9	2.1	7.0	1.5	10.0	0.8	16.0	0.3	18.4
	Bark	1.3	3.2	0.5	1.7	0.4	2.7	0.3	6.0	0.03	1.8
	Total	40.2	100.0	29.8	100.0	15.0	100.0	5.0	100.0	1.63	100.0
7	Leaf	30.1	70.3	27.9	86.9	14.1	80.6	4.3	70.5	1.5	78.9
	Twig	9.9	23.2	3.0	9.3	2.5	14.3	1.0	16.4	0.3	15.8
	Bark	2.8	6.5	1.2	3.8	0.9	5.1	0.8	13.1	0.1	5.3
	Total	42.8	100.0	32.1	100.0	17.5	100.0	6.1	100.0	1.9	100.0
10	Leaf	58.9	80.5	53.8	90.9	26.0	85.0	7.0	75.3	3.2	82.1
	Twig	9.7	13.3	3.4	5.7	2.9	9.5	1.2	12.9	0.5	12.8
	Bark	4.6	6.2	2.0	3.4	1.7	5.5	1.1	11.8	0.2	5.1
	Total	73.2	100.0	59.2	100.0	30.6	100.0	9.3	100.0	3.9	100.0

Nutrient returns (N, P and Ca) through litter fall in five different aged plantations (ages 5, 6, 7, 8 and 9) of *E. tereticornis* was estimated by Singh (1975) and similar results with that of the present study were obtained where in the highest concentration of all the nutrients was in leaf litter. It was also observed that there is considerable variation in the nutrient content of leaf and non-leaf litter. The concentration of nutrients in all the age groups of *E. tereticornis* decreases as Ca, N and P; the highest concentration being that of Ca and lowest P, which is also observed in the present investigation.

On a unit area basis the nutrients returned through litter fall in *E. tereticornis* estimated by Singh (1975) indicated that the leaf litter contributed the major portion of the total Ca, N and P. It is also observed that the total annual return as kg/ha of nutrients, is highest for Ca, followed by N and P. These results are in agreement with that of the present study.

Similar studies on nutrient return through litter fall in different forest types were carried out by Seth *et al.*, (1963) (moist deciduous forest *Shorea robusta*) Singh (1968, 1969) (dry deciduous forest) and Srivastava *et al.*, (1972) (moist deciduous forest *Shorea robusta*) and demonstrated that leaf litter returns a substantial amount of various nutrient elements. Nutrient elements are also returned to the soil through rain. George (1978) estimated the return of nutrients by rain under a *Eucalyptus* hybrid plantation and reported that the return of potassium by rain is more than that returned through litter fall while that of magnesium, is more or less the same. With regard to other elements (N, Ca, P) the major portion is returned through litter fall.

Acknowledgements

The author is highly grateful to Shri O.N. Kaul, Forest Ecologist, F.R.I. & Colleges, Dehra Dun for the co-operation rendered in undertaking these studies. Thanks are also due to the staff of Ecology Section for their co-operation in carrying out field and laboratory work and the Divisional Forest Officer, East Dehra Dun Division for the permission to carry out the field work.

SUMMARY

Studies on litter production and nutrient return in three *Eucalyptus* hybrid plantations of ages 5, 7 and 10 years of East Dehra Dun Division were carried out for one year. A total of 3377 kg/ha, 3801 kg/ha and 6207 kg/ha of litter were produced by these three plantations respectively. Of the total litter, leaf litter contributed between 66% to 76%, twigs between 16% to 24% and bark between 5% to 10%. Leaf litter, therefore, contributed the bulk of the litter fall followed by twigs and bark. Considering the nutrients in the various litter components at different ages the concentration of all the nutrients (N, P, K, Ca and Mg) was highest in the leaf followed by twigs and bark, except for Mg which showed a higher concentration in the bark than in the leaves and twigs. The concentration of nutrients in all the litter components at all the three ages decreases as Ca, N, K, Mg and P; the highest being that of Ca and N and lowest that of P. The total annual return of nutrients in all the three plantations is highest for Ca (40.2, 42.8 and 73.2 kg/ha respectively for 5, 7 and 10 years ages) followed by N (29.8, 32.1 and 59.1 kg/ha), K (15.0, 17.5 and 30.6 kg/ha), Mg (5.0, 6.1 and 9.3 kg/ha), and lowest for P (1.6, 1.9 and 3.9 kg/ha). The maximum amount of all nutrients is returned through leaf litter and lowest through bark.

युकेलिप्टस हाइब्रिड रोपवनों में आस्तरण उत्पादन और पोष्याहारों की वापसी

लेखक एम० जार्ज

सारांश

पूर्व देहरादून वन मण्डल में युकेलिप्टस हाइब्रिड के 5, 7 और 10 वर्षीय तीन रोपवनों में एक वर्ष तक आस्तरण उत्पादन और पोष्याहारों की वापसी का अध्ययन किया गया। इन तीन रोपवनों में क्रमश: कुल 3377 किलोग्राम/हेक्टे०, 3801 किलोग्राम/हेक्टेयर और 6207 किलोग्राम/हेक्टेयर आस्तरण उत्पन्न हुआ। कुल आस्तरण में से पर्णास्तरण का भाग 66 प्रतिशत से 76 प्रतिशत रहा, टहनियां 16 से 24 प्रतिशत और छाल 5 से 16 प्रतिशत रही। इस प्रकार गिरे आस्तरण का अधिकांश पर्णास्तरण से मिला जिसके पश्चात् टहनियां और छाल आते हैं। विभिन्न वयसों पर आस्तरण के विभिन्न अवयवों में पोष्याहारों पर विचार करने पर सभी पोष्याहारों (नाइट्रोजन, फास्फोरस, पोटाशियम, कैलशियम और मैग्नीशियम) का संकेन्द्रण सबसे अधिक पत्तियों में और उनके पश्चात् घटता हुआ टहनियों और छाल में पाया गया, सिवाय मैग्नीशियम के जिसका अधिक संकेन्द्रण पत्तियों और टहनियों के बजाए छाल में पाया जाता है। आस्तरण के सभी अवयवों में इन सभी तीन उम्रों में पोष्याहारों का संकेन्द्रण कैलशियम, नाइट्रोजन, पोटाशियम, मैग्नीशियम और फास्फोरस क्रम से घटता है सबसे अधिक घटत कैलशियम और नाइट्रोजन में आती है और सबसे कम फास्फोरस में। इन सभी रोपवनों में पोष्याहारों की कुल वार्षिक वापसी कैलशियम में सर्वाधिक (40.2, 42.8 और 73.2 किलोग्राम/हेक्टेयर, क्रमश: 5, 7 और 10 वर्ष की उम्र के लिए) है जिसके पश्चात् नाइट्राजन (29.8, 32.1 और 59.2 किलोग्राम/हेक्टेयर), पोटाशियम (15.0, 17.6 और 30.6 किलोग्राम/हेक्टेयर), मैग्नीशियम (5.0, 6.1 और 9.3 किलोग्राम/हेक्टेयर) आते हैं, और सबसे कम फास्फोरस है (1.6, 1.9 और 3.9 किलोग्राम/हेक्टेयर)। सभी पोष्याहारों का अधिकांश परिमाण पर्णास्तरण द्वारा और सबसे कम छाल द्वारा वापस होता है।

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NET PRIMARY PRODUCTIVITY AND PRODUCTIVE STRUCTURE OF *EUCALYPTUS TERETICORNIS* SMITH PLANTATIONS GROWN IN GANGETIC PLAIN

R.P. SINGH*

Department of Botany, Laboratory of Plant Ecology,
D.A.V. (P.G.) College, Muzaffarnagar (U.P.)

Introduction

The general term 'productivity' may be considered as the "rate of net primary production" or the rate of production of organic matter less that used in respiration but including all losses due to litter fall, root sloughing, grazing and fruit and seed fall (Egunjobi, 1969). Ovington (1962) has clearly distinguished "mean annual net primary productivity" obtained by averaging the biomass over the age of the stand, and the "current annual net primary productivity" which is the current rate of organic matter production.

Productive structure deals with the vertical distribution of organic matter of different component plant parts at different strata (Singh, 1976). Of the many species of *Eucalyptus, E. tereticornis* has been tried extensively in different parts of India for the creation of man-made forests. However, no studies have so far been undertaken in these plantations taking into consideration the total biological approach which is essential for proper understanding and management of these man-made ecosystems. There are no data available on the total biological productivity of this species which is essential in view of the fact that most of these plantations would be used for pulp where weight rather volume is important. Thus, in this investigation an attempt has been made to study the net primary productivity (both above and belowground) and productive structure of different aged plantations of *E. tereticornis* grown in Gangetic plain under comparable conditions.

Geographical location of the experimental area

The area chosen for the present investigation lies in the alluvial plain which forms a trough between the Himalayan in the North and Deccan Plateau in the South and situated at 29°11'30"N–29°45'15"N and 77°3'45"E–98°7'0"E. This trough area is also known as "Doab". In the near North of this area is Siwalik hills and in the near South is Satpura, Amravati and Vindhya hills. To the South-west is desert of Rajasthan whose influence is frequenetly felt during the summer months. The area is quite far from sea. Hight above mean sea level varies between 210 to 240 m.

Material and methods

Five to nine year old plantations of *E. tereticornis* were taken into consideration for the present study and these plantations were grown in rows at spacing of 2×2 m by the forest

*Presently Research Officer Environmental Research Station, Forest Research Institute, Press Villa, U.S. Club Estate, Simla—171 001.

department of Uttar Pradesh. Enumeration was done by quadrat method. A quadrat of 10^2 m area was used and fifty quadrats were randomly laid down in each stand. All the trees were then numbered and measured at breast height i.e., 1.37 m aboveground level. Three girth classes viz. A, B, C were developed in each stand on the basis of their (diameter at breast height) dbh as there was great variation in dbh of the trees.

Biomass studies were made by selective harvesting technique. Five trees of average diameter were harvested for each girth class and plantation age, thus total seventy five trees were felled for five stands. After felling, the sample tree was cut into one meter pieces from the base, to calculate the biomass at different strata. Leaves and branches were collected stratumwise separately for their biomass estimation in each stratum and weighed in the field. Roots of the sampled trees were dug out to a depth of one meter below and in one square meter area and weighed to calculate the underground biomass. Litter (leaf and non-leaf) was collected on monthly interval by laying down fifty quadrats (1 m^2) in each stand. The samples were weighed in the field and brought to the laboratory for dry weight estimation.

Net primary productivity was calculated by the increase in biomass in a specific time (one year) plus the amount of organic matter returned to the soil through litter fall during the same period. Mean annual net productivity (MANP) was estimated by dividing the attained growth with the corresponding age (Ovington 1957; Forrest and Ovington, 1970). Current annual net productivity (CANP) was calculated by the increase in biomass in an unit of time i.e. one year (Kira, 1969 and Jardon, 1971). The annual increase in plant weight per tree was calculated from the increment in dbh and height of the sampled trees during the study period one year; Kira and Shidei, 1967). It was done by taking measurements of dbh and height from each stand at the beginning and end of the year. Following equation was developed and used for current annual net productivity estimation:

$$Y = -3.150 + 0.028\ d^2h\ (r = 0.98)$$

where Y = Total biomass of the tree

d^2h = diameter square and height.

Current annual root production was estimated by the following formula (Newbould, 1968):—

$$\frac{\text{Aboveground production}}{\text{Aboveground biomass}} = \frac{\text{Belowground production}}{\text{Belowground biomass}}$$

Results

Litter production

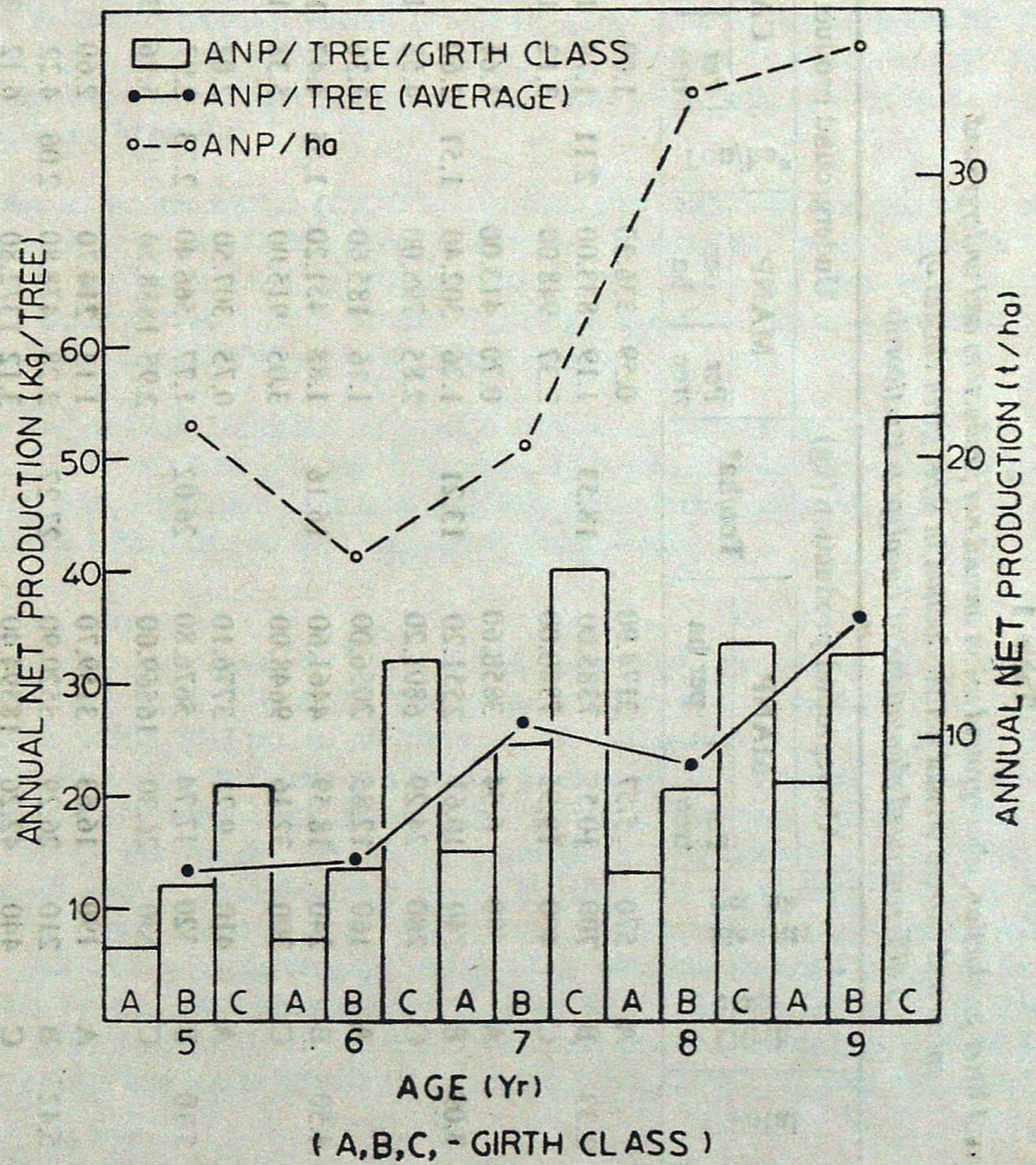
Data on the total annual litter production in different aged (5–9 year old) stands of *E. tereticornis* is furnished in Table 1. The total annual litter production increases with age being maximum (5.42 ton/ ha) in nine year old stand and minimum (2.33 ton/ha) in five year old stand. The amount of non-leaf litter is less than the leaf litter in all the study plots.

Above-ground production

Current annual net production (CANP): Total current annual net production of different aged, stands of *E. tereticornis* is calculated per plant and on per hectare basis (Fig. 1). In each

age group, the minimum organic matter production was estimated in trees of girth class-A and maximum in trees of girth class-C (Fig. 1). On hectare basis also, the trend is same but total production on area basis depends upon the density of plants. Current annual net production yields very high positive significant correlation (r=0.96) with photosynthetic biomass.

Fig. 1



Current annual net production (CANP) on per tree basis (of three girth classes and their average) and on per hectare basis of five different aged plantations of *E. tereticornis*.

Mean annual net production (MANP): Total mean annual net production of all the five stands was also calculated on per tree and per hectare basis and is furnished in Table 1. MANP increases with increasing diameter and thus in all the stands plant of girth class-A have minimum organic matter production than the trees of girth class-C. On hectare basis, MANP depends upon the number of plants per girth class. Mean annual net production and total biomass of the trees are highly correlated having correlation coefficient 0.94.

Table 1

Annual litter production, aboveground mean annual net production and underground mean and current annual net production in three girth classes of 5 different aged plantations of Eucalyptus tereticornis

Age (Yr.)	Ton/hectare		Total	Girth class	Density per ha	Aboveground production (kg)			Underground production (kg)					
						MANP		Ton/ha*	MANP		Ton/ha*	CANP		Ton/ha*
	Leaf litter	Non-leaf litter				Per tree	per ha		Per tree	per ha		Per tree	per ha	
				A	570	5.57	3174.90		0.59	336.30		1.09	621.30	
5	1.80	0.53	2.33	B	700	10.55	7385.00	18.53	1.19	833.00	2.11	1.79	1253 00	3.12
				C	400	19.95	7980.00		2.37	948.00		3,12	1248.00	
				A	590	6.54	3858.60		0.70	413.00		1.61	949.90	
6	2.30	0.79	3.09	B	240	10.63	2551.20	13.21	1.26	302.40	1.51	2.60	624.00	2.85
				C	280	24.29	6801.20		2.85	798.00		4.58	1282.40	
				A	160	12.85	2056.00		1.16	185 60		3.36	537.60	
7	3.50	1.00	4.50	B	240	18.59	4461.60	16.16	1.88	451.20	1.55	4.47	1072.80	3.22
				C	300	32.16	9648.00		3.05	915.00		5.38	1614.00	
				A	410	9.21	3776.10		0.75	307.50		2.07	848.70	
8	3.80	1.30	5.10	B	320	17.74	5676.80	26.02	1.77	566 40	2.73	2.97	750.40	5.04
				C	630	26.30	16569.00		2.95	1858.50		5.16	3250.80	
				A	190	16.63	3159.70		1.13	214.70		2.60	494.00	
9	4.00	1.42	5.42	B	210	26.29	5520.90	27.27	2.28	478.80	2.06	4.22	886.20	4.07
				C	440	42.26	18594.40		3.12	1372.80		6.12	2692.80	

*Total of three girth classes on hectare basis.

Underground production

Mean annual net production (MANP): Underground mean annual net production was also calculated per tree and on hectare basis (Table 1). MANP increases from girth class–A to girth class–C in all the stands. Minimum value (0.59 kg/tree/year) was observed in girth class–A of 5 year old stand and maximum (3.12 kg/tree/year) was determined in girth class–C of nine year old plantation. Underground mean annual net production follows the same trend as in aboveground MANP (Table 1). The total value of productivity on area basis of 5–9 year old stand was 2.11; 1.51; 1.55; 2.73 and 2.06 ton/ha/yaer respectively. Underground mean annual net production has very close positive correlation (r = 0.96) with the aboveground MANP.

Current annual net production (CANP): It increases with age and diameter of the trees. on tree basis, its minimum (1.09 kg/tree/year) value was estimated in girth class–A of five year old stand and maximum (6 12 kg/tree/year) in girth class–C of nine year old plantation (Table 1). Underground CANP shows very high significant positive correlation (r = 0.98) with the aboveground CANP and with dbh (r = 0 99).

On hectare basis, minimum dry matter production (494 00 kg/ha/year) was calculated in girth class–A of nine year old stand and maximum (3250.80 kg/ha/year) in girth class–C of eight year old plantation. The total productivity on area basis in 5–9 year old stands was 3.12; 2.85; 3.22; 5.04 and 4.07 ton/ha/year respectively.

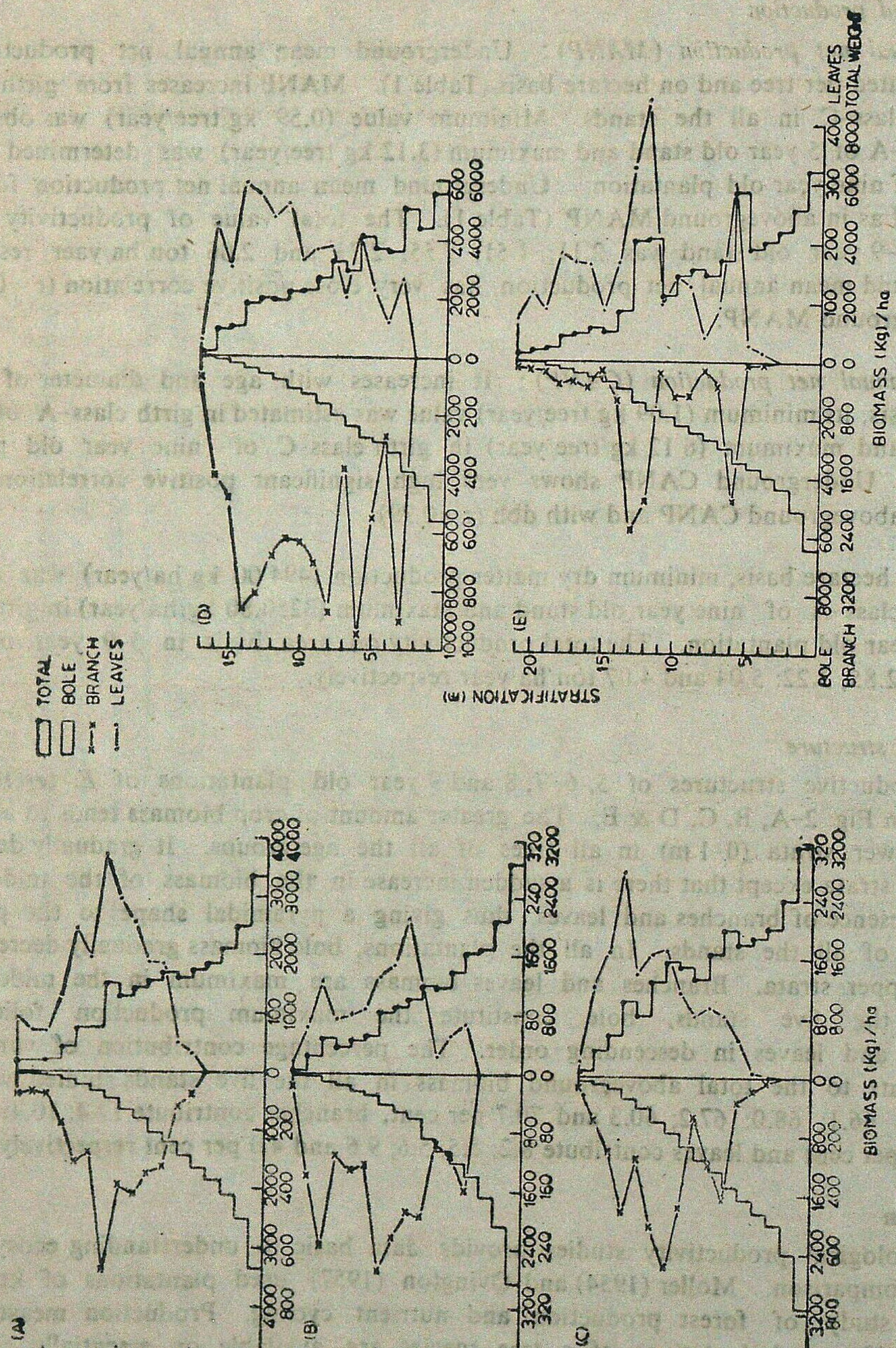
Productive structure

Productive structures of 5, 6, 7, 8 and 9 year old plantations of *E. tereticornis* are depicted in Fig. 2–A, B, C, D & E. The greater amount of crop biomass tends to accumulate in the lower strata (0–1 m) in all trees of all the age groups. It gradually decreases in the upper strata except that there is a sudden increase in the biomass of the middle strata due to presence of branches and leaves, thus giving a pyramidal shape to the productive structure of all the stands. In all the plantations, bole biomass gradually decreases from base to upper strata. Branches and leaves biomass are maximum in the middle strata. In all the five stands, bole constitute the maximum production followed by branches and leaves in descending order. The percentage contribution of various tree components to the total aboveground biomass in all the five stands studied was as bole constitute 66.1; 68.0; 67.2; 60.3 and 70.7 per cent, branches contribute 12.4; 10.4; 13.8; 16.8 and 15.6 per cent and leaves contribute 8.2; 5.5; 5.6; 9.6 and 4.0 per cent respectively.

Discussion

Biological productivity studies provide data basic to understanding ecosystems and to their comparison. Moller (1954) and Ovington (1957) used plantations of known ages for the study of forest production and nutrient cycling. Production measurement is simplified if several plantations of a tree species are available on essentially similar site under similar climatic and edaphic conditions, with stands of different ages but each with trees of a single age. The value of mean annual net primary productivity will usually be less than current annual net primary productivity because branches, leaves, twigs and bark etc., produced during the stand life has been lost by death and decay. To measure the

Fig. 2



Productive structure of five different aged plantations of *E. tereticornis.*

belowground production of a forest certainly appears to be most elaborate and difficult undertaking. Dead tissues are lost from the belowground part but cannot be measured in the same way as for the aboveground parts, where it is estimated by litter fall. Hence CANP is much more meaningful than MANP.

Results presented in Fig 1 and Table 1 clearly indicate that the values of aboveground current annual net production are higher than those of avoveground mean annual net production. Similar types of results have been obtained by Satyanarayana (1972) and Faruqi (1972) in *Shorea robusta* and *Tectona grandis* plantations. Similar differences in the two values have also been obtained by Ovington (1962). in *Pinus sylvestris* plantations. The data of abaveground current annual net production is comparable with other forest productivity (Table 2). It is seen that the annual net production of nine year old *Eucalyptus* stand is nearly equal to 40 years old *Tectona grandis* stand (572 trees/ha) and more than that of 40 years old *Shorea robusta* stand (387 trees/ha). It is obvious from Table 2 that the productivity of *E. tereticornis* is higher than that of temperate deciduous forests but less than that of tropical rain forests.

Table 2

Aboveground current annual production of different forest types of the world

Forest type	Tree density/ hectare	Ton/ha/year
Temperate deciduous forests		12.0
Temperate coniferous forest		28.0
Tropical rain forests		50.0
Illax equifolium		12.5
Tropical deciduous forest :		
*Shorea robusta*** (40 year old plantation)	387	24.2
*Tectona grandis*** (40 year old plantation)	572	36.7
Eucalyptus tereticornis (plantations)		
5 year old	1670	20.66*
6 year old	1110	16.33*
7 year old	700	20.28*
8 year old	1360	33.04*
9 year old	840	34.37*

The above Table adapted from Newbould (1967).
*Present study. **Faruqi (1972).

Lieth (1968) has estimated underground current annual net production of 7 year old *Poplar* tree and observed that underground current annual net production constitutes approximately 35 per cent of the total root biomass. The results of the present investigation are very similar to those of *Poplar* trees. In fact, more data is not available on annual root production in forests because it is very tedious job and requires a tremendous amount of labour and becomes expensive when large number of samples are required for study.

Annual litterfall study is an important expression of productivity studies (Andersson, 1970). The annual litter production increases with increasing age. From 5 to 9 year old stand, it vary between 2.33 to 5.42 ton/ha/year which is very near to values (1-6 ton/ha/year) obtained in five tropical deciduous forests communities at Varanasi (Singh, 1968).

The results of productive structure are similar to the productive structure of *Shorea robusta* and *Buchanania lanzan* (Sharma, 1971). Faruqi (1972) and Satoo (1971) have reported similar trend of vertical distribution of organic matter in *Shorea robusta*, *Tectona grandis* and *Larix laptolepis* plantations.

SUMMARY

The present investigation deals with the net primary productivity of the aboveground and underground parts and the productive structure of five different aged plantations of *Eucalyptus tereticornis*, grown in Gangetic plain of India under similar climatic and edaphic conditions The current annual net production is more than the mean annual net production both aboveground and underground parts. Aboveground current annual net production yields significant positive correlation (r=0.96) with the photosynthetic biomass while the aboveground mean annual net production shows high significant correlation (r=0.94) with biomass. Underground and aboveground current annual net production are highly correlated having significant correlation (r=0 98) and have direct bearing with dbh (r=0.99). Productive structure shows the pyramidal shape of organic matter distribution in vertical stratification

गंगा के मैदान में उगाए गए, *युकेलिप्टस टेरेटिकार्निस* स्मिथ० रोपवनों की शुद्ध प्रारंभिक उत्पादकता तथा उनकी उत्पादक संरचना

लेखक आर० पी० सिंह

सारांश

प्रस्तुत अन्वेषण का सम्बन्ध *युकेलिप्टस टेरेटिकार्निस* के पांच विभिन्न वयसों के रोपवनों की जिन्हें गंगा के मैदान में विभिन्न जलवायु और मृदा दशाओं में उगाया गया, भूमि से ऊपर और भूमि से नीचे के अवयवों की शुद्ध प्रारम्भिक उत्पादकता और उनकी उत्पादक संरचना से है। भूमि से ऊपर और भूमि से नीचे दोनों भागों में साम्प्रत् वर्षिक शुद्ध उत्पादकता माध्य शुद्ध वार्षिक उत्पादकता से अधिक है। भूमि से ऊपर साम्प्रत् शुद्ध वार्षिक उत्पादकता से सार्थक धन सहसंबंध प्रकाशसंश्लेषण जैवपुंज के साथ (r = 3.90) प्राप्त होंता है जब कि भूमि से ऊपर माध्य वार्षिक शुद्ध उत्पादन का उच्च सार्थंक सहसंबंध (r = 0.94) जैवपुंज के साथ। भूमि के नीचे और भूमि के ऊपर का साम्प्रत् वार्षिक शुद्ध उत्पादन अत्यधिक सहसंबंधित है और उनके सार्थंक सहसंबंध (r= 0.98) का वक्षोच्चता व्यास से प्रत्यक्ष सहसंबंध है (r = 0.99)। उत्पादक संरचना में खड़े स्तरीकरण में जैव पदार्थ वितरण की आकृति स्तूपाकार दिखाई देती है।

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AN ASSESSMENT OF CANE POTENTIAL OF BARATANG ISLAND IN SOUTH ANDAMAN FOREST DIVISION

S.K. SHARMA* AND P.M. BHATT

Forest Resources Survey Unit, Andaman Forest Department, Andaman

Introduction

In Andaman & Nicobar Islands the canes are widely used for rafting of sinker logs with floater logs by forest department for manufacture of cane furniture by local people and by the inmates of the cellular jail and by the agriculturists for hut construction. The utilization pattern of canes in the Island is given below from which it will be seen that more than half the quantity of canes extracted from the forest are consumed by the Andaman Forest Department for making raft of the logs for water transport :

Table 1

Showing the yearwise cosumption of canes by Forest Department and Public from 1973–74 to 1975–76 in kg

Party	1973–74	1974–75	1975–76
Forest Department	1,50,566	3,18,601	4,01,146
Purchasers	9 901	14,391	12,949
Free Grantees	2,65,382	98,729	3,34,259
	4,25,849	4,31,721	7,48,354

The demand for the canes in the Island is increasing by leaps and bounds as many units for making cane furniture on Cottage Industry basis have come up. The Sports Goods Export Promotion Council formed by the Government of India which is responsible for meeting the requirement of canes of the Sports Goods Industry mainly localized in Jullunder was also attracted towards these Islands for supply of canes to the Sports Goods Industry. The council was interested in extracting upto 1 lakh canes of 3.65 m length per year. Since no systematic survey of the cane resources of the Islands was carried out in the past, it was not possible to give any definite figure to the council regarding the availability of the canes in the Islands.

In the wake of this development the Forest Resources Survey Unit of the Andaman Forest Department was called upon to assess the cane potential of the Andaman & Nicobar Islands. In this survey Baratang Islands in South Andaman Forest Division which is rich in canes was taken first for survey.

As per the present practice the canes are weighed in kilograms for the purpose of assessment of royalty. Moisture content at which cane should be weighed –a significant factor in the case of canes which contain a good amount of water has not been specified

*Present address : Coordinator, Forest Soil-cum-Vegetation Survey, F.R.I. & Colleges, Dehra Dun.

and as such, weight of canes has become an arbitrary standard for levying royalty. In order to straighten this problem, the Andaman Forest Department is considering the levying of royalty on canes on the basis of length instead of weight. Thus in the present study the assessment of cane potential has been made both in length and in weight. The assessment of loss of weight in canes due to dryage with the passage of time has also been studied and graphs showing the loss of moisture on dryage with lapse of time have been prepared for different species of canes.

So for canes could be collected to meet the requirement from the natural forest and natural regeneration areas without much difficulty but with the increase in the demand of canes in the Islands all the nearby and easily accessible areas have been exploited for canes. No systematic management for canes has been prescribed in the various working plans except for prescribing a safe cutting cycle and cutting rules for extraction of canes. It is, therefore, high time that scientific management is prescribed for extraction of canes from the forest of these Islands so that the canes are available on a sustained yield basis in perpetuity to meet the growing demand.

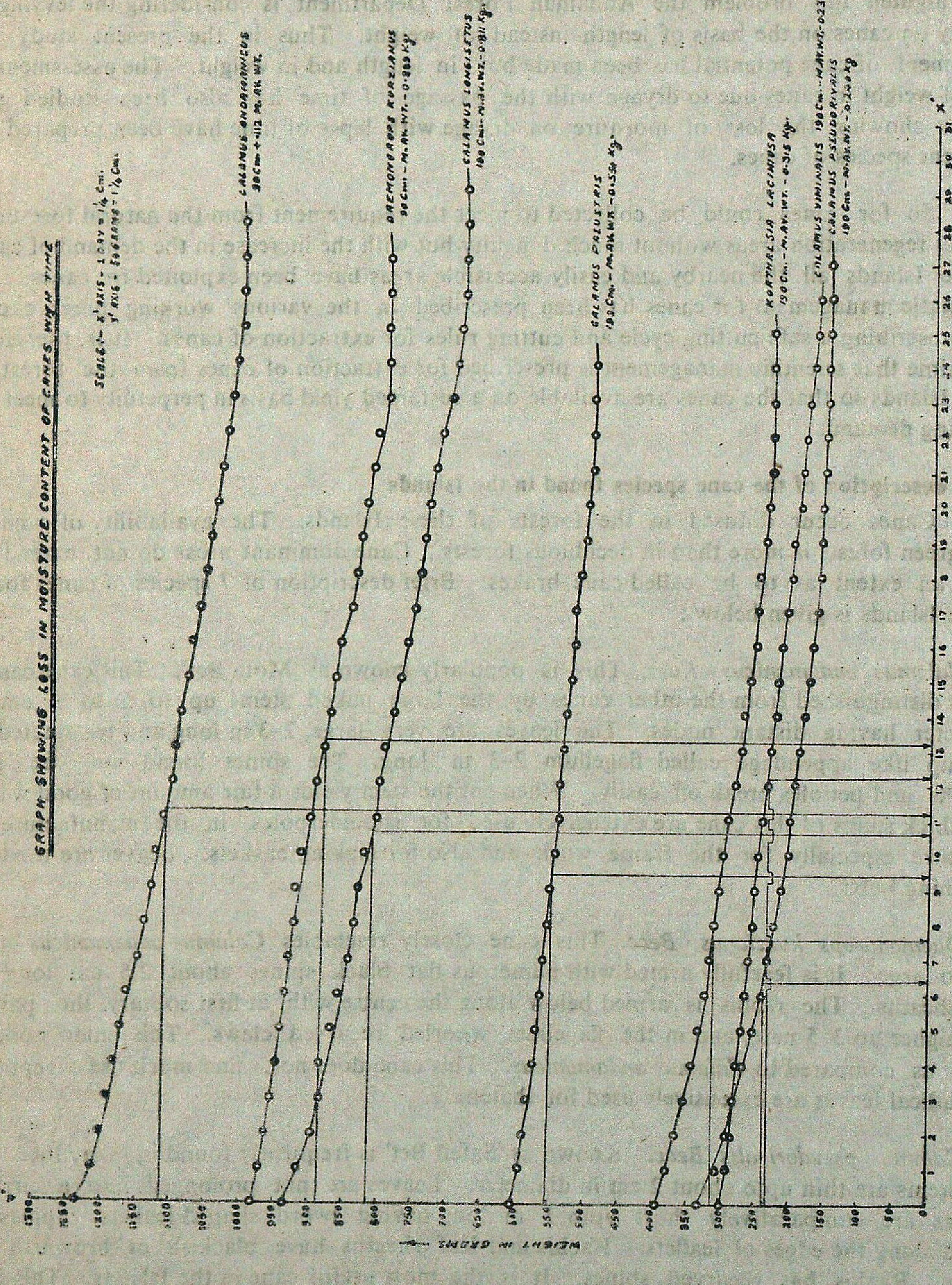
Brief description of the cane species found in the Islands

Canes occur diffused in the forests of these Islands. The availability of canes in ever green forests is more than in deciduous forests. Cane dominant areas do not extend to such an extent as to be called cane-brakes. Brief description of 7 species of canes found in the Islands is given below :

1. *Calamus andamanicus, Kurz.* This is popularly known as 'Mota Bet'. This cane can be easily distinguished from the other canes by the large naked stems up to 5 to 6 cm in diameter having distant nodes. The leaves are very large, 2–3 m long and terminated by a whip like appendage called flagellum 2–3 m long. The spines found on the leaf sheaths and petioles break off easily. When cut the stem yields a fair amount of good water. The thick stems of this cane are extensively used for shoulderpoles, in the manufacture of furniture especially for the frame work and also for making baskets. Leaves are used for thatching huts.

2. *Daemonorops kurzianus, Becc.* This cane closely resembles *Calamus andamanicus* but is not so large. It is fearfully armed with numerous flat black spines about 2.5 cm long on the sheaths. The rachis is armed below along the centre with, at first solitary, then paired, and higher up 3–5 nate, and in the flagellum whorled recurved claws. This inter node is short as compared to *Calamus andamanicus*. This cane does not, find much use except that the radical leaves are extensively used for thatching.

3. *Calamus pseudorivalis, Becc.* Known as 'Safed Bet' is frequently found in many localities. The stems are thin upto about 2 cm in diameter. Leaves are not prolonged into a cirrhus. Leaves are comparatively short upto 1 m long having sword shaped leaflets. Spines are found along the edges of leaflets. Rachis and leaf sheaths have blackish or brownish flat spines. Rachis has recurved spines. It is the most useful cane in the Islands. This cane finds extensive use in the manufacture of cane furniture, boxes, baskets etc. and also used as Walking rattans. The naked stems are greenish and strong and are used for rafting timber.


GRAPH SHOWING LOSS IN MOISTURE CONTENT OF CANES WITH TIME
CALAMUS ANDAMANICUS
DAEMONOROPS KURZIANUS
CALAMUS LONGISETUS
CALAMUS PALUSTRIS
KORTHALSIA LACINIOSA
CALAMUS VIMINALIS
CALAMUS PSEUDORIVALIS
NO. OF DAYS
WEIGHT IN GRAMS

4. *Calamus palustris, Griff.* Locally called as 'Malai Bet' and mostly confused for 'Safed Bet'. This is the easiest cane to recognise in forests on account of its broad rather distantly grouped and concave leaves which are pale beneath. It possesses a flagellum which is about 1.5 m long. This cane is sometimes used for making baskets and also as walking canes but not for making cane furniture.

5. *Calamus viminalis, Willd.* In this cane the stems are thin up to 2 cm in diameter. Sheath, petiole and rachis are armed with long spines. Leaves are upto 1.5 m long. Leaflets are fasciculate pointing many ways and rachis is not prolonged into a flagellum while spadix ends in a long slender armed appendage. This cane does not find much commercial use.

6. *Calamus longisetus, Griff.* Locally known as 'Jungli Bet': This is a large cane like *Calamus andamanicus* but can be easily distinguished by its long spines on the sheaths which are of uneven length. The leaves do not extend into a flagellum and leaflets are not evenly placed on the rachis. Leaflets are sword shaped upto half meter long and spinulous along the edges. This is a common cane found in the Islands but is not fit for any commercial use as it splits unevenly and breaks easily.

7. *Korthalsia laciniosa, Mart.* This is a conspicuous red cane common in all localities. Stem is upto 2 cm in diameter. Leaves terminate into a tendril which is spiny. Leaflets are equidistantly placed on the rachis and are ovate in shape There is a short petiole. Leaflets are irregularly toothed and pale below. This cane is locally called 'Lal Bet' and is used for making walking sticks. Leaves serve as elephant fodder.

Though 7 species of canes as mentioned above occur in Baratang Island but only 4 species out of them are prominent and commercially used. These are (i) *Calamus andamanicus,* (ii) *Calamus pseudorivalis,* (iii) *Calamus longisetus* and (iv) *Korthalsia laciniosa.* Only these four species have been taken into account for the purpose of the assessment of the cane potential of Baratang Island.

Methodology

Cane survey was first carried out by the forest resources survey unit in Baratang Island of South Andaman Forest Division. Random sampling system was adopted for the purpose. P.B.–I area demarcated earlier by the enumeration parties for preparation of Working Plan for proposed Baratang Forest Division was selected for the field work. The total area taken up for survey was 3,223 hectares. This area was divided into 123 primary blocks. Out of 123 primary blocks, 32 blocks were randomly selected. Extent of each primary block varied. 3 secondary blocks of 1 ha each were demarcated in each selected primary block. The physical measurement of canes involve cutting of cane culms into pieces. So to avoid labour and wastage each secondary block was further sub-divided into 4 equal parts.

Collection of data

Number of commercial and non-commercial culms were counted. This was just to find out the number of *immature non-commercial culms. All the commercial cane culms available in 0.25 ha area of each secondary block were cut into 3.65 m (12 ft.) billets. Number of 3.65 m billets obtained from each culm were noted. The data were tabulated as illustrated on the next page.

Periodic Block No. 8 Secondary Block No. 3

Cane species	No. of culms		Length		Weight		Potential of cane/ha	
	Commercial	Non-commercial	No. of 3.65 m Billets	Excess length	Wt. of cane for 1 m length	Total commercial Wt.	Length (m)	Weight (kg)
Calamus andamanicus	5	—	34	3.50	1.246	154 63	496.00	618.52
Calamus longisetus	5	—	25	6.00	0.445	40.60	365.00	162.42
Calamus pseudorivalis	5	—	15	2.50	0.127	6.95	219.00	27.81
Korthalsia laciniosa	—	—	—	—	0.166	—	—	—

*Canes having naked stems below 12 ft. (3.65 m) are considered immature and non-commercial.

Locality factors of the area were also taken into consideration and were noted in the proforma meant for collecting data in respect of each secondary block. The data was thus tabulated and compiled for each primary and secondary block. The data thus collected in respect of *Calamus andamanicus, Calamus pseudorivalis, Calamus longisetus* and *Korthalsia laciniosa* are given in Tables 2, 3, 4 and 5 respectively.

Weight of canes

Generally the canes are weighed after one or two days after cutting from the forests and sold to the purchasers. The weight of canes goes on decreasing as the days pass after collection as they contain lot of moisture. Thus everyday the canes after cutting loose moisture and the dry weight would be considerably less than the fresh weight immediately after cutting. Standard weight of canes was calculated by adopting the following method :

Mid girths of available canes were measured. Canes having mean girth in each specific case were cut and then weighed on the spot to find out fresh weight by taking required lengths. Weights were taken on subsequent days till the canes showed constant weight for 4 continuous days. The difference between the first weight (fresh weight) and the last weight (dry weight) will show the amount of moisture lost by canes. This is represented by the following formula :

Green weight $= W_1$

Dry weight $= W_2$

Therefore, moisture content in cane $W_1 - W_2$

So the mid weight i.e., the weight which shows half the moisture content in canes would be $\frac{W_1 - W_2}{2}$. The standard weight of canes for the purpose would be $\frac{(W_1 + W_2)}{2}$. A graph has been plotted taking the number of days on X-axis and the corresponding weight on Y-axis. The day on which the canes can be weighed after they are being cut is decided on this basis. The dry weight of canes of different species is given in Table 6.

Potential of canes

After the field work was over the data collected in the field was compild and is given in Tables 2, 3, 4 and 5. Figures obtained for each secondary block were further multiplied by 4 to get the figure for potential of canes per ha. This is because secondary blocks were earlier divided into 4 equal parts and the data was collected for 0.25 ha area only. Potential of canes in each secondary block was found like-wise and added together for a primary block. The average value for the primary block was then calculated. The total figure for each primary block thus calculated if divided by 32 will give mean potential of canes per ha as given below:

Species-wise potential of canes per ha

Species	Potential of canes/ha	
	Length (m)	Weight (kg)
Calamus andamanicus	622.69	775.871
Calamus pseudorivalis	945.53	120.082
Calamus longisetus	324.91	144.589
Korthalsia laciniosa	79.56	13.316

Standard weight of canes calculated for a particular length of cane was multiplied by required length to obtain the data in terms of weight. Similarly potential of canes per ha in weight was calculated by multiplying the standard weight of cane by the average length per ha. In the present study standard weight was obtained for a length of 90 cm in respect of *Calamus andamanicus* and *Daemonorops kurzianus* and for a length of 190 cm in respect of remaining 5 species and the same was multiplied by 1 m i.e., 100 cm then by the total length to find out potential of canes in weight.

Standard error

Standard error is the square root of sampling variance. This is calculated to know the accuracy of the results. Standard error has been calculated in each specific case, as given by V.J. Chako (1).

Conclusions

An assessment of cane potential in Baratang Island yielded the following results. The standard error shows the degree of precision of the results.

Potential of canes per ha

Cane species	Mean value per hectare		Standard error (%)	Potential of canes per hectare	
	Length (m)	Weight (kg)		Length (m)	Weight (kg)
Calamus andamanicus	622.69	775.87	± 17.97	510.79 to 734.59	638.27 to 915.47
Calamus longisetus	324.91	144.58	± 14.75	276.99 to 372.83	123.26 to 165.90
Calamus pseudorivalis	945.53	120.08	± 16.93	785.19 to 1105.77	99.76 to 140.40
Korthalsia longisetus	79.56	13.39	± 16.09	66.85 to 92.44	11.09 to 15.33

Table 2

Showing the potential of cane Calamus andamanicus in different Primary and Secondary Blocks in Baratang Island

Standard weight = 1.246 kg/m
(1 m length)

Primary Blocks	Secondary Blocks	Average potential of canes/ha	
		Length (m)	Weight (kg)
6	3, 5 & 6	584	727.664
8	3, 8 & 9	1358	1692.06
13	6. 19 & 32	126	156.99
15	6, 11 & 18	12	14.95
17	12, 15 & 32	2683	3343.01
19	5, 11 & 31	253	315.24
24	5, 9 & 12	273	340.16
25	7, 14 & 22	355	442.33
27	8, 25 & 31	547	681.56
31	21, 22 & 28	995	1239.77
33	3, 9 & 19	458	570.67
41	5, 14 & 22	326	406.20
43	4, 17 & 18	1489	1855.29
50	6, 15 & 20	566	705.24
54	3, 16 & 28	78	97.19
55	2, 5 & 7	399	497.15
56	26, 21 & 10	375	467.25
57	9, 18 & 30	555	691.53
58	33, 18 & 8	1149	1431.65
66	9, 20 & 37	423	527.06
67	5, 9 & 13	1840	2292.64
68	7, 28 & 22	321	399.97
69	3, 14 & 18	—	—
79	2, 4 & 5	44	54.82
84	2, 6 & 16	136	169.46
88	1, 4 & 6	1038	1293.35
89	1, 16 & 32	160	199.36
92	4, 19 & 33	657	818.62
93	36, 1 & 16	1957	2438.42
103	7, 23 & 31	170	211.82
117	3, 5 & 7	341	424.87
119	2, 10 & 13	258	321.47
Total :		19926	24827.764

$$\text{Average potential of canes} = \frac{19926}{32} = 622.70 \text{ m/ha}$$

Table 3

Showing the potential of cane Calamus pseudorivalis in different Primary and Secondary Blocks in Baratang Island

Standard weight = 0.127 kg/m
(1 m length)

Primary Blocks	Secondary Blocks	Average potential of canes/ha	
		Length (m)	Weight (kg)
6	3, 5 & 6	1402	178.054
8	6, 19 & 32	1392	176.784
13	6, 19 & 32	131	16.637
15	6, 11 & 18	139	17.653
17	12, 15 & 32	2307	292 989
19	5, 11 & 31	297	37.719
24	5, 9 & 12	606	76.962
25	7, 14 & 22	389	49.403
27	8, 25 & 31	681	86.487
31	21, 22 & 28	341	43.307
33	3, 9 & 19	1100	139 700
41	5, 14 & 22	1010	128.270
43	4, 17 & 18	521	66.167
50	6, 15 & 20	2399	304.673
54	3, 16 & 28	511	64.897
55	2, 5 & 7	680	86.360
56	26, 21 & 10	1265	160.655
57	9, 18 & 30	910	115.570
58	33, 18 & 8	2346	297.942
66	9, 20 & 37	258	32,766
67	5, 9 & 13	769	96.894
68	7, 28 & 22	248	31.248
69	3, 14 & 18	423	53.298
79	2. 4 & 5	5	00.630
84	2, 6 & 16	1382	174.132
88	1, 4 & 6	2170	273.420
89	1, 16 & 32	959	120.834
92	4, 19 & 33	403	50.778
93	36, 1 & 16	1616	203.616
103	7, 23 & 31	506	63.756
117	3, 5 & 7	2570	323.820
119	2, 10 & 13	521	65.646
Total :		30257	3842.639

Average potential of canes—945.53 m/ha

Table 4

Showing the potential of cane Calamus longisetus in different Primary and Secondary Blocks in Baratang Island

Standard weight = 0.445 kg/m
(1 m length)

Primary Blocks	Secondary Blocks	Average potential of canes/ha	
		Length (m)	Weight (kg)
6	3, 5 & 6	102	45.39
8	3, 8 & 9	307	136.61
13	6, 19 & 32	521	231.84
15	6, 11 & 18	214	95.23
17	12, 15 & 32	433	192.68
19	5, 11 & 31	268	119.26
24	5, 9 & 12	579	257.65
25	7, 14 & 22	433	192.68
27	8, 25 & 31	52	23.14
31	21, 22 & 28	302	134.39
33	3, 9 & 19	321	142.84
41	5, 14 & 22	438	194.91
43	4, 17 & 18	608	270.56
50	6, 15 & 20	691	307.49
54	3, 16 & 28	131	58,29
55	2, 5 & 7	691	307,49
56	26, 21 & 10	68	30,26
57	9, 18 & 30	428	190.46
58	33, 18 & 8	112	49.84
66	9, 20 & 37	647	287.91
67	5, 9 & 13	409	182 00
68	7, 28 & 22	39	17.35
69	3, 14 & 18	409	182.00
79	2, 4 & 5	83	36.93
84	2, 6 & 16	735	327.07
88	1, 4 & 6	88	39.16
89	1, 16 & 32	195	86.77
92	4, 19 & 33	282	125.49
93	1, 36 & 16	115	51.17
103	7, 33 & 31	521	231.84
117	3, 5 & 7	10	4.45
119	2, 10 & 13	165	73.42
Total:		10397	4626.37

$$\text{Average potential of canes} = \frac{10397}{32} = 324.91 \text{ m/ha}$$

Table 5

Showing the potential of cane Korthalsia laciniosa in different Primary and Secondary Blocks in Baratang Island

Standard weight = 0.166 kg/m
(1 m length)

Primary Blocks	Secondary Blocks	Average potential of canes/ha	
		Length (m)	Weight (kg)
6	3, 5 & 6	107	17.762
8	3, 8 & 9	—	—
13	6, 19 & 32	—	—
15	6, 11 & 18	—	—
17	12, 15 & 32	88	14.608
19	5, 11 & 31	—	—
24	5, 9 & 12	—	—
25	7, 14 & 22	—	—
27	8, 25 & 31	29	4.814
31	21, 22 & 28	175	29.050
33	3, 9 & 19	—	—
41	5, 14 & 22	—	—
43	4, 17 & 18	—	—
50	6, 15 & 20	394	65.404
54	3, 16 & 28	297	49.302
55	2, 5 & 7	—	—
56	26, 21 & 10	—	—
57	9, 18 & 30	—	—
58	33, 18 & 8	667	110.722
66	9, 20 & 37	44	7.304
67	5, 9 & 13	—	—
68	7, 28 & 22	185	30.710
69	3. 14 & 18	243	40.338
79	2. 4 & 5	39	6.474
84	2, 6 & 16	73	12.118
88	1, 4 & 6	64	10.624
89	1, 16 & 32	—	—
92	4, 19 & 33	141	23.406
93	3, 36 & 16	—	—
103	7, 23 & 31	—	—
117	3, 5 & 7	—	—
119	2, 10 & 13	—	—
Total :		2546	422.636

Average of 32 plots $= \frac{2546}{32} =$ 79.56 m/ha

Table 6

Showing the dry weight of canes of different species in Baratang Island

Days	*Calamus andamanicus* 90 cm	*Calamus pseudorivalis* 190 cm	*Calamus longisetus* 190 cm	*Korthalsia laciniosa* 190 cm	*Calamus viminalis* 190 cm	*Calamus palustris* 190 cm	*Daemonorops kurzianus* 90 cm
Green weight	1.237	0.332	0.934	0.392	0.300	0.605	0.980
2	1.211	0.306	0.916	0.380	0.293	0.595	0.971
3	1 202	0.292	0.898	0.367	0.289	0.590	0.963
4	1.192	0.282	0.887	0.355	0.282	0 584	0.955
5	1.185	0.270	0.887	0.346	0.278	0.578	0.950
6	1.176	0.257	0.870	0.338	0.273	0.572	0.945
7	1.167	0.243	0.860	0.328	0.267	0.568	0.937
8	1.150	0.235	0.846	0.320	0.263	0.564	0.932
9	1.143	0.226	0.839	0.313	0.258	0.563	0.925
10	1.131	0.218	0.831	0.308	0 255	0.558	0.925
11	1.127	0.209	0.825	0.300	0.250	0.555	0.018
12	1.116	0.203	0.805	0.292	0.242	0.547	0.900
13	1.105	0.198	0.802	0 285	0.236	0 542	0.898
14	1.100	0.190	0.798	0.276	0.233	0.540	0.885
15	1.092	0.185	0.782	0 272	0.228	0.535	0.878
16	1.083	0.177	0.771	0.266	0.224	0.533	0.870
17	1.077	0.173	0.763	0.258	0.217	0.524	0.861
18	1.065	0.168	0.754	0.253	0.211	0 520	0.845
19	1.055	0.163	0.749	0.251	0.205	0.520	0.840
20	1.050	0.160	0.742	0.244	0.201	0.512	0 834
21	1 041	0.160	0.735	0.241	0.196	0.505	0.826
22	1.036	0.158	0.727	0.239	0.192	0.500	0.819
23	1.027	0.155	0.719	0.238	0.188	0.498	0.813
24	1.020	0.154	0.705	0.238	0.181	0.498	0.798
25	1.015	0.153	0.698	0.238	0.174	0.498	0.798
26	1.007	0.151	0.692	0.238	0.170	0.498	0.798
27	1.007	0.151	0.688	—	0.168	—	0.798
28	1 007	0.151	0 68[illegible]	—	0.168	—	—
29	1.007	0.151	0.688	—	0.168	—	—
30	—	—	0.688	—	0.168	—	—
31	—	—	—	—	0.168	—	—
32	—	—	—	—	—	—	—

Mean standard weight/m.

1. *Calamus andamanicus* —1.246 kg.
2. *Calamus pseudorivalis* —0.127 kg.
3. *Calamus longisetus* —0.445 kg.
4. *Korthalsia laciniosa* —0.166 kg.
5. *Calamus viminalis* —0.234 kg.
6. *Calamus palustris* —0.552 kg.
7. *Demnorops kurzianus* —0.889 kg.

The number of cane pieces available per ha in accordance with the minimum length of cane piece in commercial demand is given below :

Cane species	Minimum length of cane piece in commercial demand	Availability per hectare
Calamus andamanicus	12 ft. i.e., 3.65 m	139 pieces
Calamus pseudorivalis	25 ft. i.e., 7.62 m	103 pieces
Korthalsia laciniosa	12 ft. i.e., 3.65 m	18 pieces
Calamus longisetus	12 ft. i.e., 3.65 m	75 pieces

No specification for minimum length has been made in respect of *Korthalsia laciniosa* and *Calamus longisetus* but it is presumed that a minimum length of 3.65 m (12 ft.) in respect of these canes also would serve the commercial purpose.

The Sports Goods Export Promotion Council is at present interested in commercial exploitation of *Calamus andaman cus* only. Now that, the results of cane survey show the possible availability of 139 billets of 3.65 m (12 ft.) length of *Calamus andamanicus* per ha, it is estimated that an area of about 700 ha will be required for the council for exploitation of cane to meet their demand of 1 lakh billets of 3.65 m per year. This is only a rough estimate and can be confirmed after compilation of proposed cane survey in other Islands of Andaman & Nicobar group by the Forest Resources Survey Unit.

Acknowledgement

The authors are grateful to Shri Lalthan Zama, I.F.S., Chief Conservator of Forests, Andaman & Nicobar Islands for the encouragement and interest shown by him in this survey.

SUMMARY

The cane resources of the country are fast depleting due to heavy demand and Andaman & Nicobar Islands are considered to be the last bastion for availability of canes to meet the demand locally as well as on the main land.

In order to find out the possibility of meeting the cane requirement of Sports Goods Export Promotion Council, an assessment of cane potential in Baratang Island was made adopting the random sampling mehod. An area of 3223 hectares was divided into 123 primary blocks of which 32 primary blocks were randomly selected. 3 secondary blocks of one hectare each were demarcated in each primary block. To avoid labour and wastage, secondary blocks were further divided into 4 equal parts to take one of the 0.25 hectare area for data collection. Only 4 species of canes out of 7 species were considered as the other cane species are seldom found in Baratang Island. 3 commercial species viz., *Calamus andamanicus, Calamus pseudorivalis* and *Korthalsia laciniosa* and *Calamus longisetus* though not commercial, but occurs very frequently in Baratang Island were considered. It was revealed that the potential of canes in Baratang Island with regard to standard error is as follows :

		Potential	*Standard error%*
1.	***Calamus andamanicus* (mota/Sanga Bet)**	**622.69 m/ha i.e., 775.87 kg/ha**	**± 17.97**
2.	***Calamus pseudorivalis* (Malai Bet)**	**945.53 m/ha i.e., 120.08 kg/ha**	**± 16.93**

3. *Korthalsia laciniosa*	79.56 m/ha i.e., 13.31 kg/ha	± 16.09
4. *Calamus longisetus*	324.91 m/ha i.e., 144.58 kg/ha	± 14.75

दक्षिणी अण्डमान वन मण्डल में बड़ाटांग द्वीप की बेंत संभाव्यता का आकलन

लेखक एस० के० शर्मा व पी० एम० भट्ट

सारांश

भारी मांग के कारण देश के बेंत संसाधन बहुत तेजी से खत्म होते जा रहे हैं तथा स्थानीय और मुख्य भूमि की बेंत की मांग पूरा करने के लिए अण्डमान व निकोबार द्वीप ही उपलब्धि के अंतिम दुर्ग समझे जा रहे हैं।

खेल सामान निर्यात प्रोत्साहन परिषद की बेंत आवश्यकताएं पूरी करने की संभावनाओं का पता लगाने के लिए समसंभाविक रीति अपनाकर बड़ाटांग द्वीप की बेंत संभावनाओं का आकलन किया गया। 3223 हेक्टेयर क्षेत्र 123 प्राथमिक खण्डों में बांटा गया जिसमें से समसंभाविक रीति से 32 प्राथमिक खण्ड चुने गए। प्रत्येक प्राथमिक खण्ड में एक–एक हेक्टेयर के तीन द्वितीयक खण्ड सीमांकित किए गए। श्रम और व्यर्थता बचाने के लिए द्वितीयक खण्डों को चार बराबर भागों में बांटा गया ताकि आंकड़े एकत्र करने के लिए 114 हेक्टेयर का क्षेत्र प्राप्त हो जाए। बेंत की 7 जातियों में से केवल चार जातियों पर विचार किया गया, क्योंकि बेंत की अन्य जातियां बड़ाटांग द्वीप में कहीं-कहीं ही मिलती हैं। तीन व्यापारिक बेंत जातियां अर्थात् *कैलेमस अंडमनीकस*, *कैलेमस स्यूडोरिवालिस* और *कोथाईसिया लैसिनियोसा* तथा *कैलेमस लोंगीसेटस*, जो यद्यपि व्यापारिक नहीं है किंतु बड़ाटांग द्वीप में बहुत पाई जाती है इन चार पर विचार किया गया। इससे पता चला है कि मानक विभ्रम के विचार से बड़ाटांग द्वीप में बेंत की सम्भाव्यता निम्नानुसार है।

		मानक विभ्रम प्रतिशत
1— *कैलेमस अंडमनीकस* (मोटा सांगा बेंत)	622.69 मीटर/हेक्टेयर अर्थात् 775.87 किलोग्राम/हेक्टेयर	± 17.97
2— *कैलेमस स्यूडोरिवालिस* (सनाइ बेंत)	945.53 मीटर/हेक्टेयर अर्थात् 120.08 किलोग्राम/हेक्टेयर	± 16.93
3— *कोथाईसिया लैसिनियोसा*	79.56 मीटर हेक्टेयर अर्थात 13.31 किलोग्राम/हेक्टेयर	± 19.09
4— *कैलेमस लोंगीसेटस*	324.91 मीटर हेक्टेयर अर्थात 144.58 किलोग्राम/हेक्टेयर	± 14.75

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GROWTH STUDIES OF *ACACIA NILOTICA*

S.P. SINGH

Asstt. Silviculturist,

Forest Research Institute and Colleges, Dehra Dun

Acacia nilotica (babul) is an important tree of rural areas. Its timber is utilised by village people for agricultural implements where as bark and pods are well known for tannin content and used in tanneries. On account of its hardiness and thorny nature, it thrives in areas refractory to other species and localities of excessive biotic interventions. In wake of increased stress on tree planting, plantation activities, for want of better area, are encroaching upon less favourable sites For such sites babul is most promising and now finds place in large scale plantation activities in many states like Rajasthan, Andhra Pradesh, Uttar Pradesh and Tamil Nadu.

It is unfortunate that growth data for this important species are not available for guide to produce maximum yield returns from planted stands. The reason is that adequate sample plots are not available to prepare yield tables. However, attempt has been made here to give approximate growth trends for the species using tree model approach (Singh, 1981).

Data to determine species dependent coefficients of the model were derived from permanent sample plots of Uttar Pradesh (Southern Doab S.P. 17, 11, 9, 8 and 7, Northern Doab 2, 4, 11 and 10) and Rajasthan (Chittorgarh S.P. 1, Udaipur S.P 2). Details pertaining to data used in the analysis are as under:

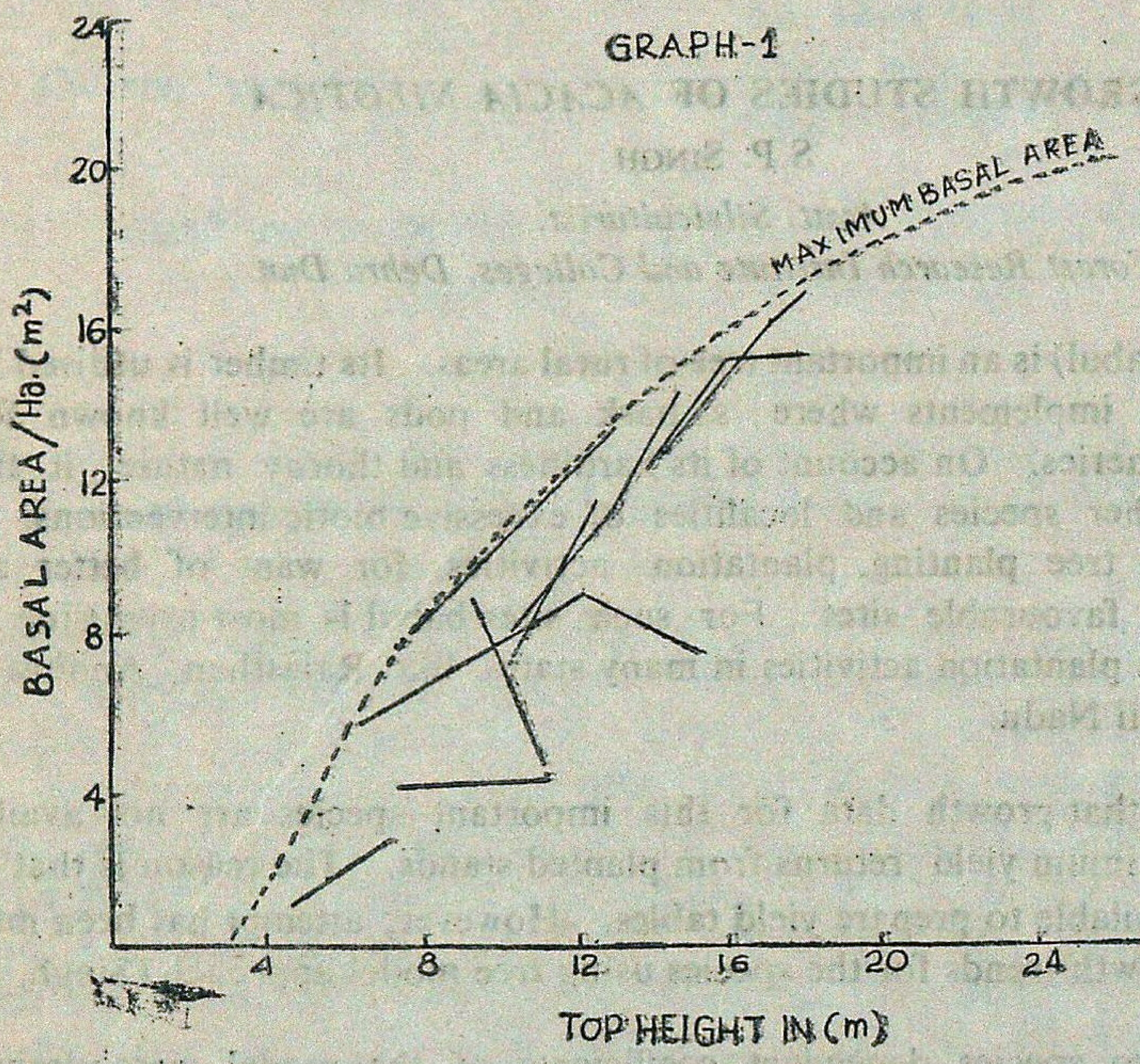
No. of sample plots	Total number of observations
11	26

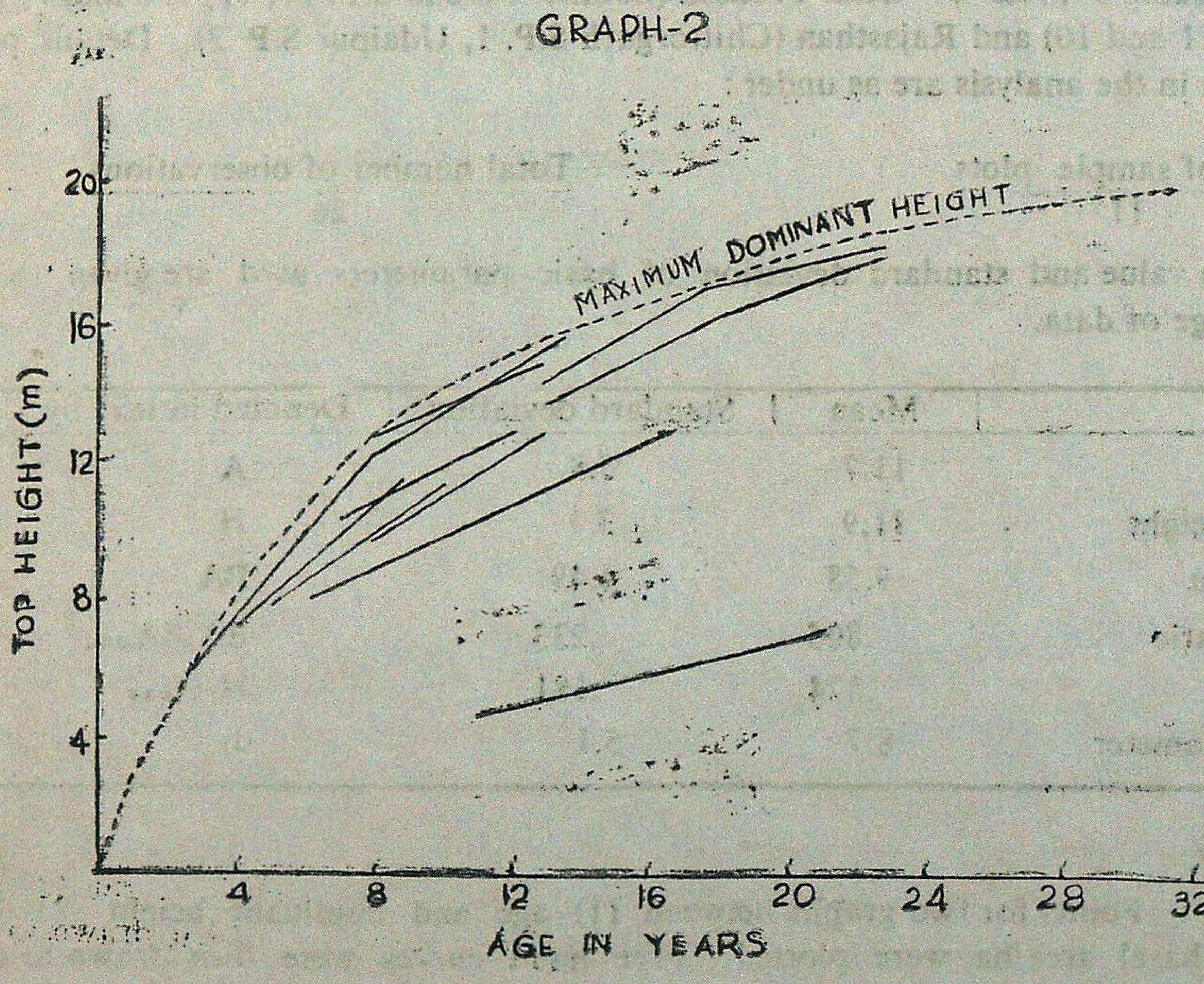
Mean value and standard deviation of basic parameters used are given to indicate size and range of data.

Parameter	Mean	Standard deviation	Denoted in text by	Unit
Age	11.7	5.8	A	year
Dominant height	11.9	3.7	H	metre
Basal area/ha	9.58	4.49	BA	m^2/ha
Basal area ratio	.805	.233	BA/BA_{max}	—
Height ratio	.874	.181	H/H_{max}	—
Minimum diameter	8.7	5.1	d_1	cm

Methodology

Step I: Points for two graphs between (1) age and dominant height (2) dominant height and basal area/ha were plotted. Free hand curves were then drawn to cover the


GRAPH-1
MAXIMUM BASAL AREA
BASAL AREA/Ha. (m²)
TOP HEIGHT IN (m)
4 8 12 16 20 24
4 8 12 16 20 24


GRAPH-2
MAXIMUM DOMINANT HEIGHT
TOP HEIGHT (m)
AGE IN YEARS
4 8 12 16 20
4 8 12 16 20 24 28 32

maximum observed values (BA_{Max} and H_{Max}). Suitable functions to fit points taken from hand drawn curves were found. This procedure yielded the following relationships:

$$BA_{Max} = 27.4 \left(1 - e^{-.0671(H-3)}\right)^{1.02412}$$

$$Log_e\, H_{Max} = 3.26208 - 3.27252\, A^{-.70988}$$

Dominant height corresponds to the height of a tree of dominant diameter, where dominant diameter is mean diameter of 125 thickest trees/ha.

Step II: The diameter measurements of a year in permanent sample plot after arranging in ascending order were grouped into ten diameter classes and mean diameter (d) of each group was determined. In the first stage a sigmoid relationship between cumulative probability (p) (in the present case .05, .15, .25......, .95) and mean diameters was developed for each measurement of all the sample plots i.e. 63 observations by the following simple regression.

$$\phi = \frac{d - d_1}{a + bd}$$

$$\text{Where } \phi = \log_{10}\left[\frac{20\,(p+.05)}{\text{Log}_{10}\,[100-(p+.05)]}\right]$$

d_1, corresponds to $p_1 = .05$ and 'a' and 'b' are the intercept and the slope. The variation of d_1, a and b was studied with reference to various independent variables like dominant height, age of the crop, height ratio H/H_{Max} and basal area ratio 'q' which is an index of competition.

$$q = \frac{BA}{BA_{Max}}$$

The choice finally rested on the following extended model which takes into account these variables which produce statistically significan effect on the behaviour of the model.

(a) $d_1 = 1.40189\, A. \frac{H}{H_{Max}} - 1.61096\, A. \frac{BA}{BA_{Max}} + 8.39721 \frac{BA}{BA_{Max}}. \text{Log}_{10} A$

$- 7.96964 \frac{H}{H_{Max}} + .70975 \frac{BA}{BA_{Max}}, \frac{H}{H_{Max}} A + 3.55604$

T — value for regression coefficients are 6.578, 3.579, 2.454, 2.494 and 1.674 successively.

$R = .952$

(b) $\phi = \frac{d - d_1}{a + bd}$ ... ... (iii) such that

(i) $a = -.63321\, d_1 + .24426 \left[\frac{H}{H_{Max}}\right]^2. A - .39664$

and (ii) $b = -.01960\, d_1 + .94264$

T—values for regression coefficients in (i) are 9.683 and 5.546 respectively and in (ii) these are 6.443 and 24.605 respectively.

Multiple correlation coefficient $R = .898$.

Step III : At first instance the logarithmic relationship between tree height (h) and diameter at breast height (d) was developed. These height and diameters of representative trees in sample plot are measured at the time of each measurement to develop height diameters relationship :

$$Log_{10} = a' + b' \log_{10} d$$

Variation in "intercept a' " is explained more than "slope b' " by independent variables and hence variation in intercept is retained in regression in generating family of height/diameter curves for different site qualities. The following regression for intercept was obtained.

$$a' = 1.22099 \frac{H}{H_{Max}} \cdot \frac{BA}{BA_{Max}} \quad \log_{10} A - .07466\ A. \frac{H}{H_{Max}} \cdot \frac{BA}{BA_{Max}}$$

$$+ .51692 \log_{10} A - .49508$$

T—value for coefficients are 6.428, 5.733 and 4.002 successively

$R = .706$

In estimating tree heights, the regression thus used was

$$\log_{10} h = \log_{10} d\ (\log_{10} H - a')/(\log_{10} d_{dom}) + a'$$

Step IV : For volume estimation the regression developed in earlier years (Sharma & Jain, 1977) was utilised—

$$V = .00208 + .411526\ D^2H$$

Where D = tree diameter in metres

For the best site quality of the locality i.e. $H/H_{Max} = 1$, the maximum basal area per ha is attained when BA/BA_{Max} equals one. Yield tables for 3 different levels have been calculated with the help of there regressions (Annexure 1).

In calculating thinning yields from low (ordinary) thinnings the distribution has been assumed to follow the following curves.

$$P_i^* = p_i \left(\frac{1}{L} - 1\right) \quad \ldots \quad \ldots \quad \text{(vi)}$$

Where p_i^* is i^{th} term of probability of vector p^* which relates to stem in the stand that will be left after thinning.

$$P^* = (p_1^*, p_2^* \ldots\ldots\ldots\ldots\ldots\ldots\ldots P_n^*)$$

and L is the ratio of the stocking after thinning to the stocking before thinning.

The study reveals that in best locality, there should be about 1196 number of trees in plantation at 5 years of age to obtain maximum volume output from the site and how the reduction in number of trees should be applied during future years of management. This best growth is attained on canal bank plantations. Generally babul attains 10 to 12 m of height at 25 years in dry tracts where it is capable of yielding M.A.I. 3 to 4 cm^3/ha.

Annexure 1

Yield Table

(Before thinning statistics upto Col. 7)

Age (yrs.)	Dominant Height (m)	Dominant Diameter (cm)	Mean diameter by basal area method (cm)	Number of trees/ha	Basal area/ha (m^2)	Total volume/ ha (m)	Volume thinned (m^3)	M.A.I. (m^3)
1	2	3	4	5	6	7	8	9
Height ratio 1.0								
5	9.2	16.9	9.8	1196	9.07	36.63	6.83	7.33
10	13.8	21.8	16.0	691	13.89	88.42	12.82	9.53
15	16.2	24.4	19.8	514	15.88	120.75	13.88	9.36
20	17.7	26.3	22.7	417	16.97	143.94	15.38	8.87
25	18.7	27.8	25.2	354	17.67	162.61	—	8.46
Height ratio 0.8								
5	7.4	13.6	7.6	1473	6.71	20.83	4.17	4.17
10	11.0	18.7	12.8	872	11.18	55.40	6.91	5.96
15	12.9	21.3	15.9	660	13.11	77.36	7.72	5.90
20	14.1	23.3	18.3	541	14.20	92.83	7.86	5.58
25	15.0	24.8	20.3	462	14.91	104.35	—	5.24
Height ratio 0.6								
5	5.5	10.3	5.9	1487	4.07	9.18	1.13	1.84
10	8.3	15.0	9.8	1059	7.93	28.79	2.72	2.99
15	9.7	17.4	12.0	855	9.69	41.83	3.13	3.05
20	10.6	19.2	13.7	726	10.71	50.92	3.21	2.90
25	11.2	20.8	15.1	634	11.38	57.60	—	2.71

SUMMARY

Tree model to simulate growth and yield of Bubul has been developed. With its help, it is feasible to predict yields obtainable under different site conditions and different prediction intensify of low (ordinary) thinnings. It thus can provide information to decide initial spacing for planting so as to obtain maximum volume output from the site.

अकेसिया नीलोटिका की वृद्धि के कुछ अध्ययन

लेखक एस० पी० सिंह

सारांश

बबूल की वृद्धि और प्राप्ति के रूपायन के लिए वृक्ष प्रतिरूप का विकास किया गया है। इसकी सहायता से विभिन्न स्थल दशाओं तथा पूर्वनिर्धारित विभिन्न निम्न (साधारण) विरलन सघनताओं में मिलने वाली प्राप्तियों का पूर्वकथन किया जा सकता है। इस प्रकार यह रोपते समय वृक्षों में प्रारम्भिक फासला कितना रखा जाए निश्चित करने के लिए जानकारी दे सकती है जिनसे उस स्थल से अधिकतम आयतन मात्रा प्राप्त की जा सके।

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Regd. Office :—
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(Arunachal Pradesh)

Head Office :—
P.O. Deomali–786629
Distt. Tirap
(Arunachal Pradesh)

1/82–12/82

NATURAL CHLOROPHYLL MUTANTS IN *ALBIZZIA LEBBEK* BENTH.

O.P. Rajora and M.S. Rawat

Indo-Danish Project, Seed, Procurement and Tree Improvement,
F.R.I. and Colleges, Dehra Dun

Introduction

Spontaneous chlorophyll mutations detected as white, yellow, yellow green seedlings have been reported in several temperate species. Franklin (1970) has reviewed the litrature on this subject in the species of the family *Pinaceae*. Venkatesh and Thapliyal (1977) have recorded chlorophyll mutants in Himalayan Chir Pine. However, there are very few well documented records in the tropical broad leaved species (in *Bombax cieba* by Venkatesh and Emmanuel, 1976, *Gmelina arberea* Roxb. by Venkatesh *et al.*, 1978). The present note records the occurrence of such mutations in *Albizzia lebbek* Benth; a tropical broad leaved species. *A. lebbek* being very valuable and fast growing species, an increasing interest has been created to include this species in Social Forestry Programme in India and subsequently in tree improvement programme. First stage provenance collections have been done by the authors and in due course a regular controlled breeding programme is quite likely to develop on this species.

Material

Chlorophyll mutants were detected in various groups of seedlings grown from provenance seed collection. 14 lots of open pollinated seeds were collected from mother trees scattered over its natural distribution in northern India from longitude 73°40′E to 86°54′E. The seeds were sown in the pots filled with soil during the month of May '81.

Observations

The Chlorophyll mutants were recorded among open pollinated progenies raised from the seeds of Pinjore, Jaipur and Udaipur origins.

The chlorophyll mutants detected were of the following kinds :

Viridis : Stem, cotylendons and leaves are yellow-green. These seedlings survive about 10–15 days after germination and then die away.

Xantha : Stem, cotyledons and leaves are yellow in colour. These seedlings survive for 7–10 days after germination and then die away.

Albina : These seedlings are white in colour and are totally lacking in chlorophyll. They die within 3–7 days of seed germination.

In Table 1 are enumerated such of the seed sources whose progenies contained one or more of mutant seedlings. The percentage frequencies of chlorophyll mutants are given :

Table 1

Kind and percentage of chlorophyll mutants in open pollinated progenies of different sources

Source	*Viridis*	*Xantha*	*Albina*
Pinjore	—	2.94	2.94
Jaipur	—	—	6.25
Udaipur	4.31	3.45	—

Anatomical studies were carried out by cutting free hand sections of cotyledons and leaves of both normal and chlorophyll mutants and observing them under ordinary light microscope. Anatomical studies revealed that mesophyll cells of cotyledons and leaves were densely packed with many large chloroplast, while the mesophyll cells of albino seedling contained non or very few small chloroplasts, which presumably lacking chlorophyll synthesizing ability. In case of albino leaves palisade tissue was rudimentary in comparision to well developed palisade tissue of normal green seedlings. *Xantha* and *Viridis* type of seedlings showed intermediate conditions of chloroplast occurrence.

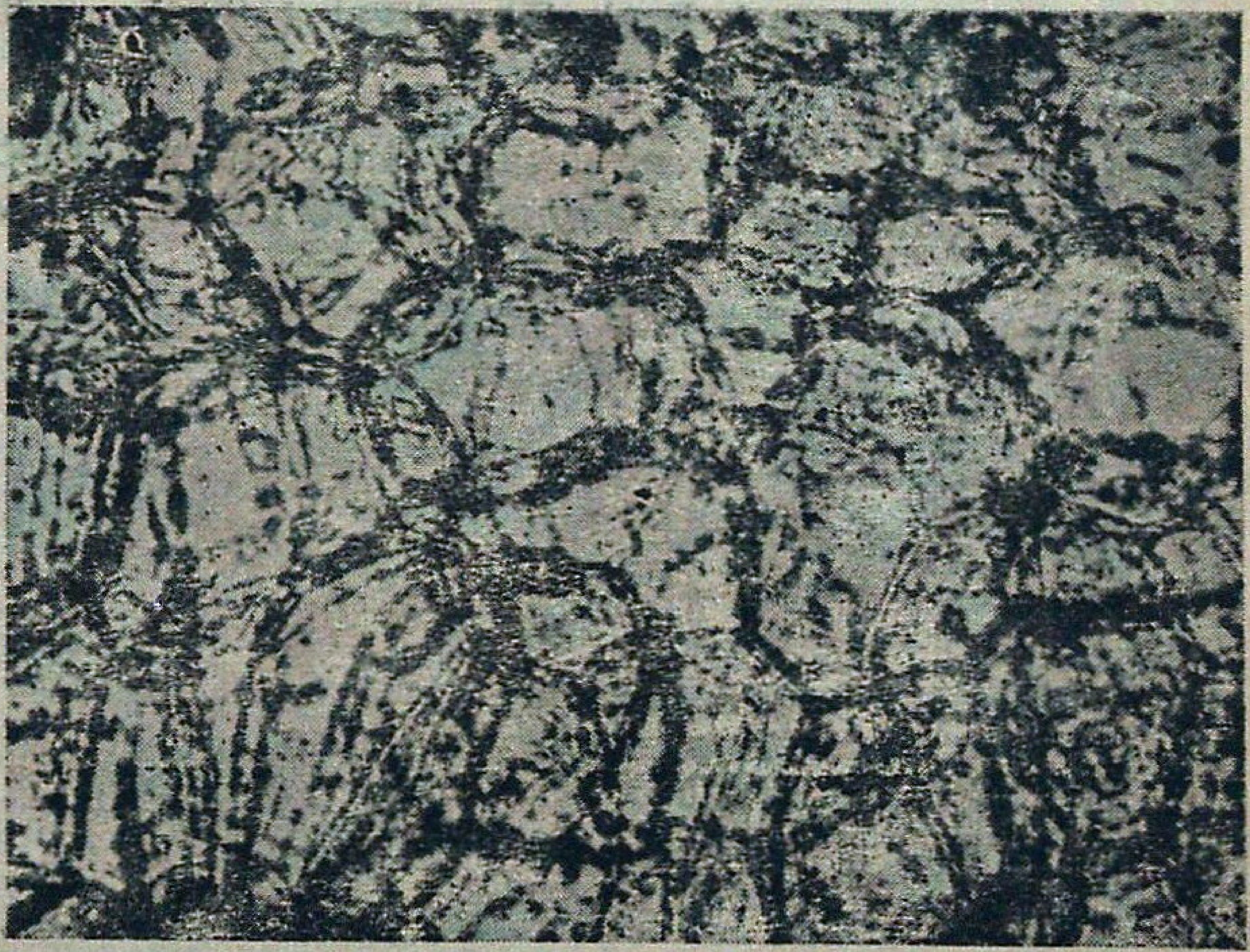
Chlorophyll mutants in this species possibly be originated as a result of selfing of heterozygous trees for this character or by crossing inter-Sec, between two such heterozygous trees.

(a) Normal seedling, (b) *Viridis* type of Chlorophyll mutant, (c) *Xantha* type of Chlorophyll mutant, (d) *Albina* type of Chlorophyll mutant.

Discussions

There are very few well documented cases of Chlorophyll lethals known in tropical forest tree species. Gustaffsson (1940) has classified various kinds of Chlorophyll mutants. The mutant seedlings in this species conformed to the *Albina*, *Xantha* and *Viridis* types of that classification. The lethal albino homozygots can not be utilized practically. However, the clone individual heterozygous for such mutant traits can be of importance as genetic markers for monitoring the degree of natural crossing and selfing in future Seed Orchards established for genetic improvement of *Albizzia lebbek*.

(a) T.S. of Cotyledon of normal green seedling



(b) T.S. of Cotyledon of albino seedling

SUMMARY

Occurrence of three kinds of natural chlorophyll mutants *Viridis*, *Xantha* and *Albina*—in *Albizzia lebbek* Benth. is reported; the first of its kind in this tropical forest tree species. Such Chlorophyll mutations can be of potential value as early genetic marker in seed orchard management.

Key words : **Chlorophyll mutants, *Albizzia lebbek* Benth.**

एल्बीज्जिया लेब्बेक बेंथम के प्राकृतिक पर्णशाद उत्परिवर्ती

लेखक ओ० पी० रहोरा व एन० एस० रावत

सारांश

एल्बीज्जिया लेब्बेक बेन्थम में पाए जाने वाले तीन प्राकृतिक पर्णशाद (क्लोरोफिल) उत्परिवर्तियों अर्थात् वीरिडिस, जैन्थिया और एल्बिना–को मिलता सूचित किया गया है; उष्णदेशीय वन वृक्ष जातियों में अपनी किस्म का यह प्रथम बार हुआ है। बीजोद्यान का प्रबन्ध करने के लिए जल्दी जननिक सूचना देने में ऐसे पर्णशाद उत्परिवर्ती संभावित मूल्य वाले हो सकते हैं।

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SOIL BIOSEQUENCES OF A FOREST LAND OF DUN VALLEY WITH REFERENCE TO ITS VEGETATION*

R.M. SINGHAL, J.S. SAMRA, S.D. SHARMA, P. PANDE AND S.K. SHARMA

Forest Research Institute and Colleges, Dehra Dun

Introduction

Considerable attention has been paid in the recent past on relationship between soil and vegetation for determining various aspects of a forest land and its productive status. Large scale afforestation in India has also brought into prominance the need for a more comprehensive knowledge of the mineral status of the forest lands. Many studies carried out in this direction (Khan and Yadav, 1962; Seth and Bhatnagar, 1963; Qureshi and Yadav, 1966, Bhatnagar *et al.*, 1967) reveal the interest and importance for such studies in the intensive management of forest areas. Mach attention has been paid on this aspect in other countries particularly for solving problems of soil fertility and nutritional requirements, but not much has been done in Indian Forestry on these lines excepting few (Sharma *et al.*, 1980; Samra *et al.*, 1980). The present study is an attempt in this direction which deals with the interactions between vegetation and soil characteristics of an area in Doon Valley having nearly level toposequence, same parent material, age and climate and minimum of interference due to human activities but having different vegetation viz., sal (*Shorea robusta*), teak (*Tectona grandis*) and miscellaneous species in the top storey adjacently.

Material and Methods

Study site

(a) *Location*—The area comprises of compartment No. 7b of the Lachhiwala Block (Dehra Dun, East Forest Division) with Lachhiwala-Kansrao road as the boundary on the eastern side and a nala on the western side. On the northern and southern boundaries of the area are other compartments of the Block (Fig. 1).

(b) *Climate*—The area enjoys sub-tropical climate with temperature varying from 0°C (December-January) to 41°C (May-June). Frost is quite common during winter and causes damage to young sal regeneration. The prevailing winds are from west and are generally of moderate velocity. The mean annual rainfall is 1526 mm with maximum in the June-September.

(c) *Parent material, relief and soil*—The parent material in the area is 'Dun alluvium' and the soils have developed from alluvium. The area is almost flat with elevation of 500 m above m.s.l.

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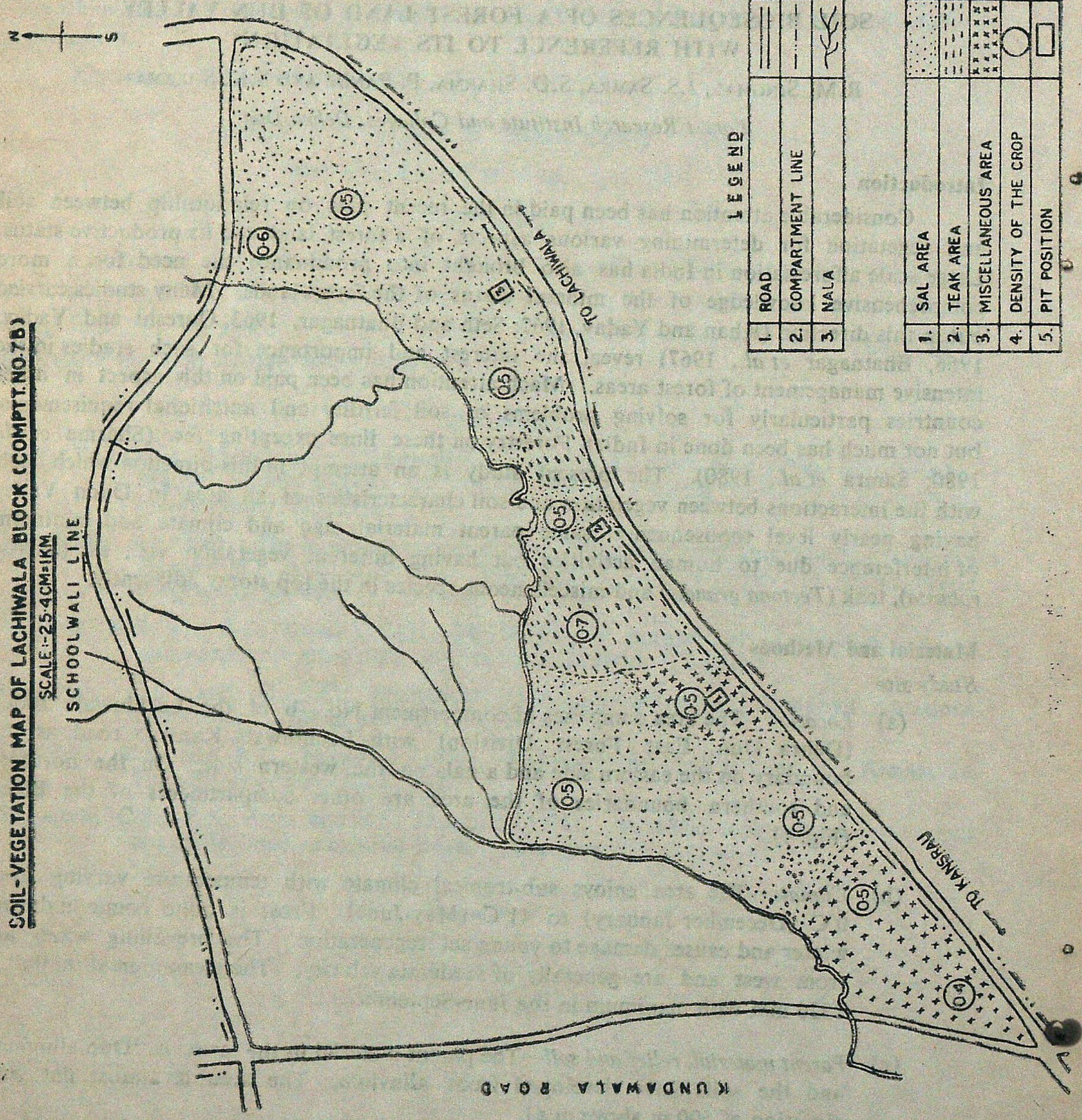
*Presented in the International Symposium on 'Tropical Rural Ecosystem' held at A.P.S. University, Rewa from 13.11.80 to 15.11.80.


SOIL-VEGETATION MAP OF LACHIWALA BLOCK (COMPTT. NO. 7B)
SCALE:-25·4CM=1KM.
SCHOOLWALI LINE
TO LACHIWALA
TO KANSRAU
KUNDAWALA ROAD
N
S
LEGEND
1. ROAD
2. COMPARTMENT LINE
3. NALA
1. SAL AREA
2. TEAK AREA
3. MISCELLANEOUS AREA
4. DENSITY OF THE CROP
5. PIT POSITION
0·6
0·5
0·7
0·4

(d) *Vegetation*—The forest type of the area as per Champion classification is $3C/C_2b(1)$ (North Indian Moist Deciduous Forests). The principal species is sal (*Shorea robusta*) in association with *Terminalia, tomentosa, Terminalia belerica* and *Anogeissus latifolia*. The density of crop varies from 0 5 to 0.7 in the quality class II/III. Old teak (*Tectona grandis*) plantation of 1954 (Sample Plot No. 56) in 0.269 ha (quality class III) and a patch of miscellaneous forest also exist in the area. The under wood consists of *Anogeissus latifolio, Mallotus philippinensis, Ehretia laevis*, etc. whereas undergrowth consists of *Adhatoda vasica, Clerodendron* species, *Flemingia chappar*, etc. *Acacia pinnata* and *Mimosa* species are the common climbers found in the area (Misra, 1970).

Survey of the area

The method followed for survey of the area was essentially the same as described by Qureshi and Yadav (1967). The survey work was preceded by a preliminary inspection of the area to acquaint with the major physiographic and other locality factors. Auger borings of 60 cm or less depth (if the auger could not work deeper) were made at every grid of 5×2 m chains and observations recorded on organic matter, pH, calcareousness, etc. On the basis of auger borings and distinguishing vegetation, soil pits of 2 m depth were excavated and soil samples collected for analysis and classification purposes (USDA, 1978). Vegetation around each of the three pits was also recorded as given below :

Vegetation predominance	Profiles		
	I	II	III
1. Over wood	*Shorea robusta*	*Tectona grandis*	*T. tomentosa*
	T. tomentosa		*L. grandis*
	A. latifolia		*A. latifolia*
	T. belerica		
2. Under wood	*M. philippinensis*	Mostly absent	*M. philippinensis*
	O. dalbergioides	except sporadic	*E. laevis*
	E. Laevis	*M. philippinensis*	*C. fistula*
	C. fistula		
3. Ground cover	*M. koenigii*	*M. koenigii*	*M. koenigii*
	C. oppositifolia	*F. chappar*	*C. oppositifolia*
	F. chappar	*Clerodendron* species	*F. chappar*
Predominance	Sal	Teak	Misc.

The morphological description of the three profiles is given below :

Profile I: 2.5 km west of Song river.

Horizon	*Depth (cm)*	*Morphological description*
A_{11}	0–3	Brown (10 YR 5/3, dry); silty clay loam; medium moderate sub-angular blocky; dry soft; smooth abrupt boundary; pH 6.6.
A_{12}	3–7	Pale brown (10 YR 6/3, dry); silty clay loam; medium moderate sub-angular blocky; dry soft; smooth clear boundary; pH 6.5.
A_{13}	7–12	Light yellowish brown (10 YR 6/4, dry); silty clay loam; medium moderate sub-angulr blocky; dry soft; smooth gradual boundary; pH 6.4.
B_{21t}	12–38	Yellowish brown (10 YR 6/6, dry); silty clay; fine moderate angular blocky; dry slightly hard; smooth clear boundary; pH 6.1.
B_{22t}	38-67	Yellowish brown (10 YR 5/6, dry); silty clay; fine moderate sub-angular blocky; dry slightly hard; smooth diffused boundary; pH 5.9.
B_3	67–180	Yellowish brown (10 YR 5/6, dry); silty loam; weak moderate sub-angular blocky: dry slightly hard; pH 6.4; roots not present.

Profile II: Near tree No. 42 of the teak sample plot No. 56.

A_{11}	0–4	Brown (10 YR 5/3, dry); silty loam; medium moderate sub-angular blocky; dry soft; smooth abrupt boundary; pH 6.5.
A_{12}	4–10	Yellowish brown (10 YR 5/4, dry); silty loam; medium moderate sub-angular blocky; dry soft; smooth clear boundary; pH 6.5.
B_{21t}	10–20	Light yellowish brown (10 YR 6/4, dry); silty clay loam; fine moderate sub-angular blocky; dry slightly hard; smooth gradual boundary; pH 6.6
B_{22t}	20–70	Yellowish brown (10 YR 5/6, dry); silty clay; fine moderate sub-angular blocky; dry hard; smooth diffused boundary; pH 6.3.
B_{23t}	70–180	Brownish yellow (10 YR 6/6, dry); silty clay; fine moderate sub-angular blocky; dry hard; pH 6.1.

Profile III: 3 km west of Song river.

A_{11}	0–25	Yellowish brown (10 YR 5/4, dry); silty loam; fine moderate sub-angular blocky; dry soft; clear smooth boundary; pH 6.1.
B_1	25–44	Yellowish brown (10 YR 5/6, dry); silty clay loam; fine weak sub-angular blocky; dry soft; clear smooth boundary pH 5.4.
B_{21t}	44–67	Yellowish brown (10 YR 5/6, dry); silty clay; fine weak sub-angular blocky; dry hard; smooth gradual boundary; pH 5.8.
B_{22t}	67–101	Strong brown (7.5 YR 5/6, dry); silty clay; fine weak sub-angular blocky; dry hard; irregular diffused boundary; pH 6.0.
B_{23t}	101–180	Brownish yellow (10 YR 6/6, dry); silty clay; fine weak sub-angular blocky; pH 5.7, few roots present.

Results and discussion

It can be seen from the Table 2 that the soils under investigation are generally silty loam to silty clay in texture, acidic to near natural in reaction and containing a high content of organic carbon. The main distinguishing feature of these soils is a thin mollic epipedon of loamy texture and presence of argillic horizons in them. The higher percentages of saturated bases and clay in sub-surface horizons indicate adequate level of available nutrients in them. These soils are also free from the growth limiting horizons such as indurated hard pan or cemented calcium carbonate. However, when these soils are compared within themselves it is seen that the soils under sal have lower content of exchangeable calcium and low Ca; Mg ratio as compared to the soils under teak or miscellaneous. The per cent base saturation is also less in the case of former soils indicating their comparatively lower fertility level as compared to the soils under teak and miscellaneous species as also indicated by the density of crop. It can also be seen from the Table 1 that the Ca; Mg ratio in the case of former soils is more in the A horizon in comparison to B horizon, whereas it is otherwise in the latter soils where the ratio is more in the B horizon. This can be accounted for by the phytorecycling of calcium from the lower horizon to the upper horizon in the case of soil under sal and also the higher content of calcium than magnesium of the leaves of teak (*Seth et al.*, 1963). However, role played by the vegetation in the development of the soils is comparatively more pronounced in the case of the soils under sal as compared to the other two as reflected by lesser increase in the calcium of their A horizon.

Acknowledgement

The study is based on the soil science exercise carried out by the trainees of 22nd Special Refresher Course under the senior author. The senior author is thankful to them for their effort in surveying the area and also to Dr. M.N. Jha, Officer-in-Charge, Forest Soils Branch, F.R.I., Shri S.P. Banerjee, Senior Research Officer, F.S.V.S. and Shri T.C. Pathak, Research Assistant I, Soils Branch, F.R.I. for their help at various stages during the study of the area.

Table 1

Profile No.	Vegetation	Thickness of horizon (cm)		Exchangeale Ca; Mg ratio		Percent base saturation		Average clay content (%)	
		A	B	A	B	A	B	A	B
1	Sal	12	168	0.25	0.12	28.5	29.4	30.1	34.6
2	Teak	10	170	0.33	0.41	42.5	72.3	24.7	39.5
3	Misc.	25	155	0.42	0.56	69.8	70.9	30.8	41.0

Table 2

Physico-chemical characteristics of soil of three profiles

Profile No. (Vegetation)	Horizon	Depth (cm)	pH 1 : 2.5	Organic carbon (%)	Mechanical analysis			C.E.C. m e. (%)	Exchangeable cations m.e. (%)				Sum of cations	Percent base saturation
					Sand (%)	Silt (%)	Clay (%)		Ca	Mg	Na	K		
1 (Sal)	A_{11}	0–3	6.6	1.88	36.8	34.4	28.8	23.6	1.8	6.7	0.39	0.57	9.45	40.0
	A_{12}	3–7	6.5	1.41	34.8	34.4	30.8	27.0	1.8	3.8	0.37	0.52	6.49	24.0
	A_{13}	7–12	6.4	1.12	34.9	34.3	30.8	22.0	—	4.0	0.37	0.40	4.76	21.6
	B_{21t}	12–38	6.1	0.64	26.1	32.8	41.3	27.0	—	5.9	0.37	0.35	6.62	24.5
	B_{22t}	38–67	5.9	0.52	29.2	31.2	39.7	24.7	—	6.4	0.41	0.26	7.06	28.6
	B_3	67–130	6.4	0.52	42.0	35.1	22.9	20.4	2.0	4.2	0.53	0.47	7.19	35.2
2 (Teak)	A_{11}	0–4	6.5	2.64	42.5	32.7	24.7	17.7	1.8	6.6	0.36	0.44	9.21	62.0
	A_{12}	4–10	6.5	1.48	44.7	30.6	24.7	13.7	1.2	2.6	0.43	0.27	4.51	32.9
	B_{21t}	10–20	6.6	0.96	38.1	30.4	31.5	14.5	2.2	6.1	1.80	0.43	10.53	72.6
	B_{22t}	20–70	6.3	0.72	26.9	28.7	44.4	16.7	2.6	7.0	1.70	0.48	11.77	70.5
	B_{23t}	70–180	6.1	0.52	26.6	30.9	42.5	15.6	3.2	6.2	1.70	0.43	11.53	73.9
3 (Misc.)	A_{11}	0–25	6.1	1.00	31.0	45.5	23.5	18.8	3.2	7.7	1.60	0.62	13.12	69.8
	B_1	25–44	5.4	0.69	26.7	35.2	38.1	15.9	2.6	6.2	1.60	0.51	10.91	68.6
	B_{21t}	44–67	5.8	0.44	23.9	31.4	44.7	18.4	3.2	6.4	1.70	0.50	11.79	64.1
	B_{22t}	67–101	5.8	0.60	21.6	33.5	44.8	17.1	4.2	7.0	1.70	0.41	13.31	77.8
	B_{23t}	101–180	5.7	0.52	23.7	33.2	43.1	18.9	4.2	7.6	1.60	0.38	13.77	72.9

SUMMARY

Interrelationship between the soils and vegetation have been discussed in respect of a forest land of Doon Valley (U.P.) having sal (*Shorea robusta*), teak (*Tectona grandis*) and miscellaneous species as its main vegetation. The soils under various types of vegetation differ marginally from one another at various levels. The soils under teak and miscellaenous species contain comparatively more available nutrients than soils under sal, which has otherwise sustained greater interaction by vegetation during the course of their development.

वनस्पतियों के संदर्भ में दून घाटी की एक वन भूमि में मृदा का जीव अनुक्रम

लेखक आर० एम० सिंहल, जे० एस० सामरा, एस० डी० शर्मा, पी० पांडे व एस० के० शर्मा

सारांश

इस अभिपत्र में मृदा और वनस्पति के पारस्परिक संबंधों को दूनघाटी (उ० प्र०) की वन भूमि को लेकर विवेचित किया गया है जिसमें शाल (*शोरिया रोबस्टा*), सागौन (*टेक्टोना ग्रांडिस*) और कुछ फुटकर जातियां प्रधान वनस्पति के रूप में उगी हुई हैं। विभिन्न वनस्पति प्रकारों की मिट्टियों में विभिन्न स्तरों पर एक दूसरे से थोड़ा ही अन्तर है। सागौन और फुटकर जातियों की मृदा में साल की मृदा की तुलना में उपलब्ध पोष्याहार अधिक हैं परन्तु साल मृदा में वनस्पति विकास के दौरान अन्यथा अन्योन्य सतत क्रिया प्रतिक्रिया अधिक होती है।

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A NOTE ON ROOTING RESPONSE IN *DALBERGIA LATIFOLIA* ROXB. CUTTINGS BY PLANT HORMONES

K.S. NEGI
Silviculture Branch, Regional Forest Research Centre, Jabalpur (M.P.)

Introduction

In this paper certain hormones namely Indole acetic acid (IAA), Indole butyric acid (IBA) and Napthyle acetic acid (NAA) have been tried on the rooting behaviour of *Dalbergia latifolia* cuttings.

Materials and methods

Rooting experiments were carried out with cuttings made from 1 year old twigs of mature tree of *Dalbergia latifolia* in August, 1980. The cuttings of 23 cm long and 0.5 cm diameter were chosen for experimental purposes. All the leaves and the apex with juvenile leaves were removed from the cuttings. The cuttings were dipped in the plant hormone solution of IAA (100 ppm), IBA (100 ppm) and NAA (100 ppm) for 48 hrs. Some cuttings were similarly treated with ordinary water which served as control. The cuttings 5 in number in each treatment were then sown in earthen pots containing garden soil and kept in a shed covered by roof, open from all sides and judicious watering was done in the morning and evening throughout the experimental period. The detailed results on the rooting behaviour of the cuttings are presented in Table 1.

Table 1

Results of application of IAA, IBA and NAA on the rooting of Dalbergia latifolia after 240 days of sowing of cuttings*

Treat-ments	Month of sowing	No. of cutting sown.	No. of cuttings rooted.	% of root-ing	Meen length of roots	Appr. average number of roots	No. of twigs formed	Av. length of twig	Av. No. of leaves
IAA 100 ppm	August' 80	5	4	80	9.5 cm	24	7	9.4 cm	41.5
IBA 100 ppm	-do-	5	2	40	6 cm	21	4	4.5 cm	22.0
NAA 100 ppm	-do-	5	2	40	6 cm	19	3	4.3 cm	18.5
Control	-do-	5	1	20	3 cm	5	1	2 cm	6.0

Results and discussion

The application of hormonal treatment IAA, IBA and NAA caused a considerable increase in the rooting potential of the cuttings, while in untreated control cuttings rooting was very poor. Rooting was assessed after 240 days* of sowing of cuttings.

*Preliminary observation could not be taken.

There was higher percentage of rootings (80 %) in the cuttings treated with IAA. The mean root length was also superior in this treatment. Other treatments IBA and NAA also exhibited improved response over control, but in these treatments the rooting response was only 40 per cent. The hormones, both in terms of number of roots per cutting and percentage of cuttings, producing roots, were superior to increase the rooting quality of the cuttings. No rooting improvement was observed in trials of *D. latifolia* cuttings conducted during February, May and November 1980. This indicated seasonal effect on the rooting response of the plant cuttings, such variations in response due to seasons were also recorded by Nanda *et al.*, (1968) and Nanda (1972), Bhatnagar (1973), Ghosh and Bhatnagar (1977).

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SUMMARY

Rooting response in *Dalbergia latifolia* Roxb. branch cuttings by the application of different plant hormones was studied. The rooting potential was observed best by application of Indole acetic acid (IAA) 100 ppm, Indole butyric acid (IBA) 100 ppm and Napthyle acetic acid (NAA) 100 ppm could induced moderate (40%) rooting respoase, while in untreated control it was poor. The detailed results have been discussed.

पादप हार्मोन उपयोग करने पर डलबर्ग्रिया लेटिफोलिया राक्सब० की कलमों में जड़ें
निकलने के प्रतिचार संबंधी टिप्पणी

लेखक के० एस० नेगी

सारांश

विभिन्न पादप हार्मोन देने पर डलबर्ग्रिया लेटिफोलिया राक्सब० की शाखा कलमों में जड़ें निकलने के प्रतिचार का अध्ययन किया गया । जड़ें निकलने की संभाव्यता सबसे अच्छी इंडोल एसेटिक अम्ल (आई ए ए) 100 भाग प्रति दस लाख भाग पानी में मिलाकर देने पर हुई । इंडोल ब्यूटरिक अम्ल (आई बी ए) 100 भाग प्रति लाख भाग पानी में और नैप्थाइल ऐसेटिक अम्ल (एन ए ए) 100 भाग प्रति दस लाख भाग पानी में देने से जड़ें निकलने का मध्यम प्रतिचार (40 पतिशत) ही प्रेरित किया जा सका, अनुपचारित नियामक में यह घटिया रहा । विस्तृत परिणाम विवेचित भी किए गए हैं ।

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FIVE NEW COMBINATIONS AND A NEW NAME FOR INDIAN FLOWERING PLANTS

M.B. RAIZADA* AND S.S.R. BENNET**

The correct name of *Hamiltonia suaveolens* Roxb. is *Spermadictyon suaveolens* Roxb. (Santapau & Merchant in Bull. Bot. Surv. India 3 : 110, 1962). Roxburgh (Cor. Pl. 3 : 32, 1815) in the original description metioned the flower colour as pure white. The plant with azure-blue flowers was described as a distinct species, *Spermadictyon azureum* Wall. ex Roxb. (1824), and G. Don (1834) also treated it as a distinct species. Voigt (1845) treated it as a variety under *Hamiltonia suaveolens.* Hooker f. (1881) and later botanists did not give any distinct taxonomic status to this and completely merged it with *H. suaveolens.* However, after seeing the plant with azure-blue flowers in the field and in gardens, it is clear that Voigt's taxonomic treatment is the appropriate one for this plant. Therefore, the correct name and the synonyms are :

Spermadictyon suaveolens Roxb. var. azureum (Wall.) Bennet & Raizada *comb. nov.*

S. azureum Wall. in Roxb., Fl. Ind. 2 : 225. 1824.

S. suaveolens sensu Raizada & Saxena, Fl. Mussoorie 1 : 303. 1978.

Hamiltonia suaveolens Roxb. var. *azurea* (Wall.) Voigt, Hort. Sub. Calc. 387. 1845.

H. suaveolens sensu Hook. f., Fl. Brit. India 3 : 197. 1881 *p.p.*

According to A.C. Smith (Amer. J. Bot. 28 : 438. 1941) *Hippocratea* L. is monotypic and American. The species treated under *Hippocratea* in Indian Floras are referable to the genera *Loeseneriella* A.C. Smith and *Reissantia* N. Halle (Ding Hou in Blumea 12 : 32. 1963). As *Hippocratea bourdillonii* Gamble falls within the circumscription of *Loeseneriella* the following combination is necessary for this species.

Loeseneriella bourdillonii (Gamble) Bennet & Raizada *comb. nov.*

Hippocratea bourdillonii Gamble in Kew Bull. 1916 : 132. 1916. & Fl. Pres. Madras 1 : 153. 1957 (rep. ed.).

The following new combination is necessary for the species known by the name *Ophiorrhiza calcarata* Hook. f. as the synonym *Mussaenda repens* Wall. ex G. Don is available for combination under *Ophiorrhiza* L.

Ophiorrhiza repens (Wall. ex G. Don) Bennet *comb. nov.*

Mussaenda repens Wall. ex G. Don, Gen. Syst. 3 : 491. 1834.

Ophiorrhiza calcarata Hook. f., Fl. Brit. India 3 : 84. 1880; Kar & Panigrahi in Bull. Bot. Surv. India 5 : 233. 1965.

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*Formerly Chief Research Officer and Head, Division of Botany, F.R.I. & Colleges, Dehra Dun.
**Research Officer, Systematic Botany Branch, F.R.I. & Colleges, Dehra Dun.

Salvia lanata Roxb. (1820) is a later homonym of *Salvia lanata* Salisb. (1796). Therefore, a new name is proposed here. The specific epithet is in honour of Dr. S.K. Mukerjee, former Keeper of the Central National Herbarium, Howrah, who revised the Indian Labiatae.

Salvia mukerjeea Bennet & Raizada *nom. nov.*

S. lanata Roxb., Fl. Ind. 1 : 146. 1820 (non Salisb. Prodr. 1796); Hook. f., Fl. Brit. India 4 : 654. 1885; Peter & Stibal, Fedde Repert. 39 : 185. 1936; Mukerjee in Rec. Bot. Surv. India 14 (1) : 108. 1940; Raizada & Saxena, Fl. Mussoorie 1 : 593. 1978.

S. integrifolia Hardwicke, Asiat. Res. 6 : 349. 1799, non Ruiz. & Pavon 1798.

Panigrahi adopted *Eusteralis* Rafin. as the correct name for *Dysophylla* El-Gazzar & Watson ex Airy Shaw and while transferring all the Indian species under *Eusteralis* he maintained *Dysophylla gracilis*, *D. erecta* and *D. quadrifolia* as distinct species. Keng in his revision of Malesian Labiatae treated *D. gracilis* and *D. erecta* as a single taxon of verietal rank under *D. tomentosa* and *D. quadrifolia* as a variety under *D. stellata*. When one follows Keng's taxonomic treatment for these taxa, which we follow, the correct names and the relevent synonyms should be as follows—

Eusteralis tomentosa (Dalz.) Panig. var. **gracilis** (Dalz.) Bennet & Raizada *comb. nov.*

Dysophylla gracilis Dalz. in Hook., Kew J. 2 : 337. 1850; Hook. f., Fl. Brit. India 4 : 641. 1885.

D. erecta Dalz. in Hook., Kew J. 2 : 337. 1850; Hook. f., Fl. Brit. India 4 : 641. 1885.

D. stellata Benth. var. *gracilis* (Dalz.) Cooke, Fl. Bombay 2 : 458. 1908; Gamble, Fl. Madras 1137. 1924; Mukerjee in Rec. Bot. Surv. India 14 (1) : 81. 1940.

D. tomentosa Dalz. var. *gracilis* (Dalz.) Keng in Gard. Bull. Sing. 24 : 72. 1969.

Eusteralis gracilis (Dalz.) Panig. in Phytologia 32 : 476. 1976.

E. erecta (Dalz.) Panig. in Phytologia 32 : 477. 1976.

Eusteralis stellata (Lour.) Panig. var. **roxburghiana** (Keng) Bennet & Raizada *comb. nov.*

Dysophylla stellata var. *roxburghiana* Keng in Gard. Bull. Sing. 24 : 72. 1969.

D. quadrifolia Benth. in Wall., Pl As. Rar. 1 : 30. 1830; Hook. f., Fl. Brit. India 4 : 639. 1885 : Mukerjee in Rec. Bot. Surv. India 14 (1) : 72. 1940.

Eusteralis quadrifolia (Benth.) Panig. in Phytologia 32 : 478. 1976.

SUMMARY

Five new combinations and a new name are proposed for Indian Flowering plants.

भारतीय पुष्पन पादपों के पांच नए संयोग तथा एक नया नाम

लेखक एम० बी० रायजादा व एस०एस०आर० बेनेट

सारांश

भारतीय पुष्पन पादपों के पांच नये संयोग और एक नया नाम प्रस्तावित किए गए हैं ।

ALTERNATIVE PACKAGE FOR APPLE

R.C. TANDON AND J.B. SINGH
Timber Mechanics Branch,
Forest Research Institute & Colleges, Dehra Dun

Introduction

A Scientific approach to develop suitable containers for various end uses is necessary to achieve optimisation, not only with respect to meet up the functional requirements of the package but also with the view to utilising our meagre resources to the fullest advantage. Economy plays a very important role in the selection of a package for a particular use but sometimes, longterm economy is sacrificed for immediate gains.

Apples grow in the hilly regions of Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh. Its production has been increasing in recent years and consequently the number of boxes required for the packaging of apples is increasing. The current requirement of Himachal Pradesh alone is about 1 crore boxes annually and at least the same quantity of apple boxes are required by J. & K. and U.P. (Shukla, 1979) as well.

Wood on account of its cheapness, availability and favourable working qualities has remained an ideal material for such packages. All timber based industries are facing acute shortage of timber and packaging industry is no exception to it. Therefore, demand for alternative materials or designs using less amount of wood is fast increasing.

Most perishable products require ventilation so that they can 'breathe' in transit and strorage, to retard decay. A container for perishable products like apples, therefore, must provide openings for these essential functions and it also must be able to withstand the high humidity and high stacking common in cold storages and trucks. But many openings, high humidity and high stacking tend to weaken non-wooden packages. Suppliers of non-wooden packages may try to compensate this by the addition of chemicals and by increasing the amount of materials used. This often does little more than increasing package cost (Modern Packaging Eneyclopedia –1971).

Moreover in India due to lack of proper roads to several orchards and lack of facilities to protect apple boxes from rains during transhipment and marketing, the problem of replacing conventional wooden containers has become very difficult. Besides this, cost consideration is also a preventive factor for the replacement.

In the past wooden veneer baskets (Stern, 1949) were used in United States of America, for transporting products from farm to consumers. The first veneer basket was fashioned by hand but later mechanical devices were developed that did away with slow and laborious hand operations. It is also in the literature that wooden veneers if pastedwith kraft paper restricts the tendency of veneer to split along the grain and this combination was used for packing purposes (Panshin *et al.*, 1950).

With this background it was thought that it might be possible to use wooden veneer and kraft paper combination in place of plywood for making boxes similar to battened plywood cases (IS 2674–1964), which might replace conventional wooden boxes. The results obtained on few combination of wooden veneer and paper are reported in this paper.

Material and methods

Sound logs (girth more than 1 m) of mango *Mangifera indica* and toon (*Toona ciliata*) were procured from the local market. They were converted into 1 mm and 3 mm thick veneers by rotary cut method (peeling) in Composite Wood Branch of this Institute after heating them in water pond for about 3 days. The veneers were dried to about 12% moisture content. Such dried veneers are used by plywood factories for making plywood and would be available from plywood factories for making veneer boxes.

3 mm thick veneers were covered with kraft paper or newspaper on both the sides either by pasting or by stitching. The stitching was done with a stitching machine commonly used for making corrugated fibre boxes. The glue used for pasting was sodium silicate.

Another sheet material tried uses three veneers each 1 mm thick which were put together such that adjacent veneers had grains in mutually perpendicular direction similar to plywood construction. These veneers were neither bonded using glue or stitching wire nor covered with karft paper or newspaper as it was thought that this combination might not fail due to splitting because of the veneers being in mutually perpendicular grain directions.

Boxes of the internal size 45 cm × 30 cm × 30 cm were prepared using battens of the cross section 2 cm × 1 cm from fir *(Abies pindrow)* and one of the sheet materials mentioned above (Fig. 1). For comparison similar boxes using better known sheets e.g. 3 mm thick commercial plywood and 3 mm thick tempered hardboard were also made, six slits, 3 each on the two side faces, of the size 110 mm × 3 mm were provided for 'breathing' in all the boxes.

Five boxes with the above battens and one type of sheet, were tested for their capacity to withstand top-bottom compression and similar number of boxes were tested for their capacity to withstand flat drop on each face from a constant height of 1 m (Shukla, 1979). The former gives an idea of stacking load and the latter of rough handling. The results obtained are given in Table 1 which also includes the values obtained for wooden box made of fir (*Abies pindrow*) of approximately the same size, used in Himachal Pradesh for apple packaging (Shukla, 1979). This has been included to judge the prospects of the alternate boxes to replace conventional wooden apple boxes.

Results and discussions

All the alternative boxes had better capacity to withstand flat drop as compared to conventional wooden boxes (Fig. 2) and their capacity to withstand top-bottom compression is comparable with the exception of boxes using 1 mm thick veneer to the conventional wooden box (Fig. 3). The value 2000 kg obtained for top-bottom compression of the box using 1 mm thick veneers is about 2/3rd of the wooden box. But it appears that this box should be able to withstand the expected stacking load of about 250 kg if used as apple box.

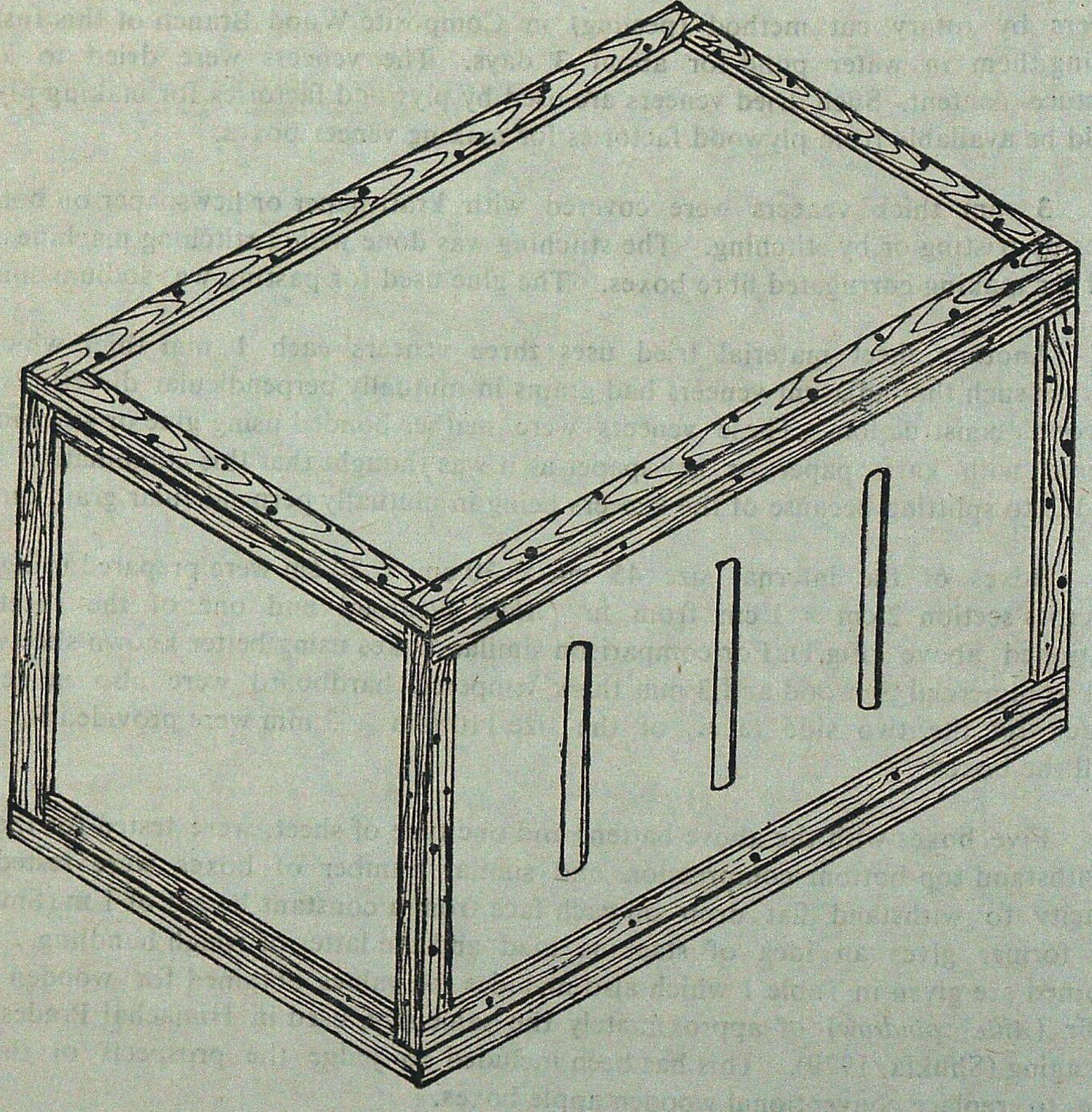


FIG. 1

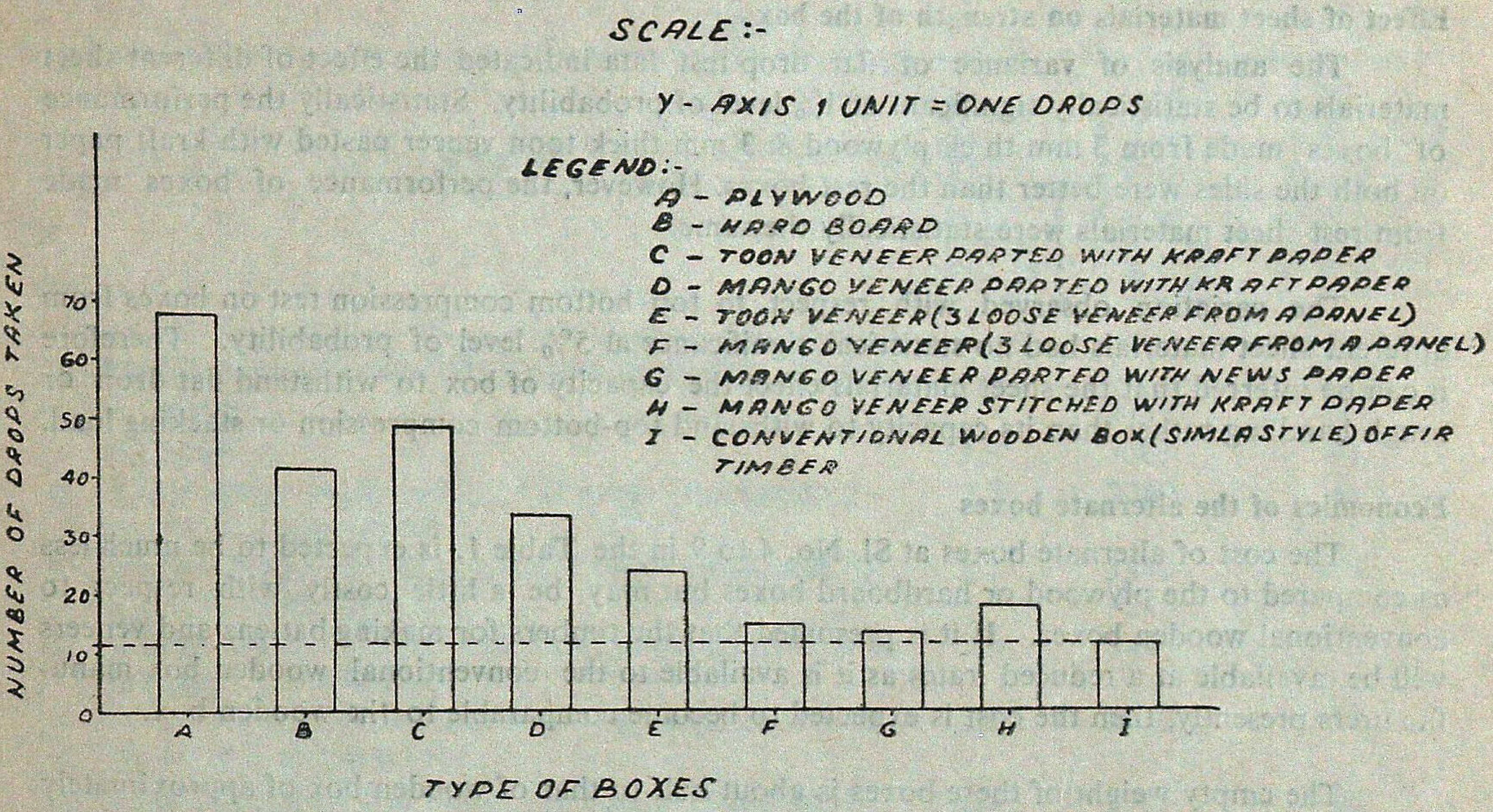

SCALE:-
Y-AXIS 1 UNIT = ONE DROPS
LEGEND:-
A - PLYWOOD
B - HARD BOARD
C - TOON VENEER PARTED WITH KRAFT PAPER
D - MANGO VENEER PARTED WITH KRAFT PAPER
E - TOON VENEER (3 LOOSE VENEER FROM A PANEL)
F - MANGO VENEER (3 LOOSE VENEER FROM A PANEL)
G - MANGO VENEER PARTED WITH NEWS PAPER
H - MANGO VENEER STITCHED WITH KRAFT PAPER
I - CONVENTIONAL WOODEN BOX (SIMLA STYLE) OF FIR TIMBER
NUMBER OF DROPS TAKEN
70
60
50
40
30
20
10
0
A
B
C
D
E
F
G
H
I
TYPE OF BOXES

FIG 2

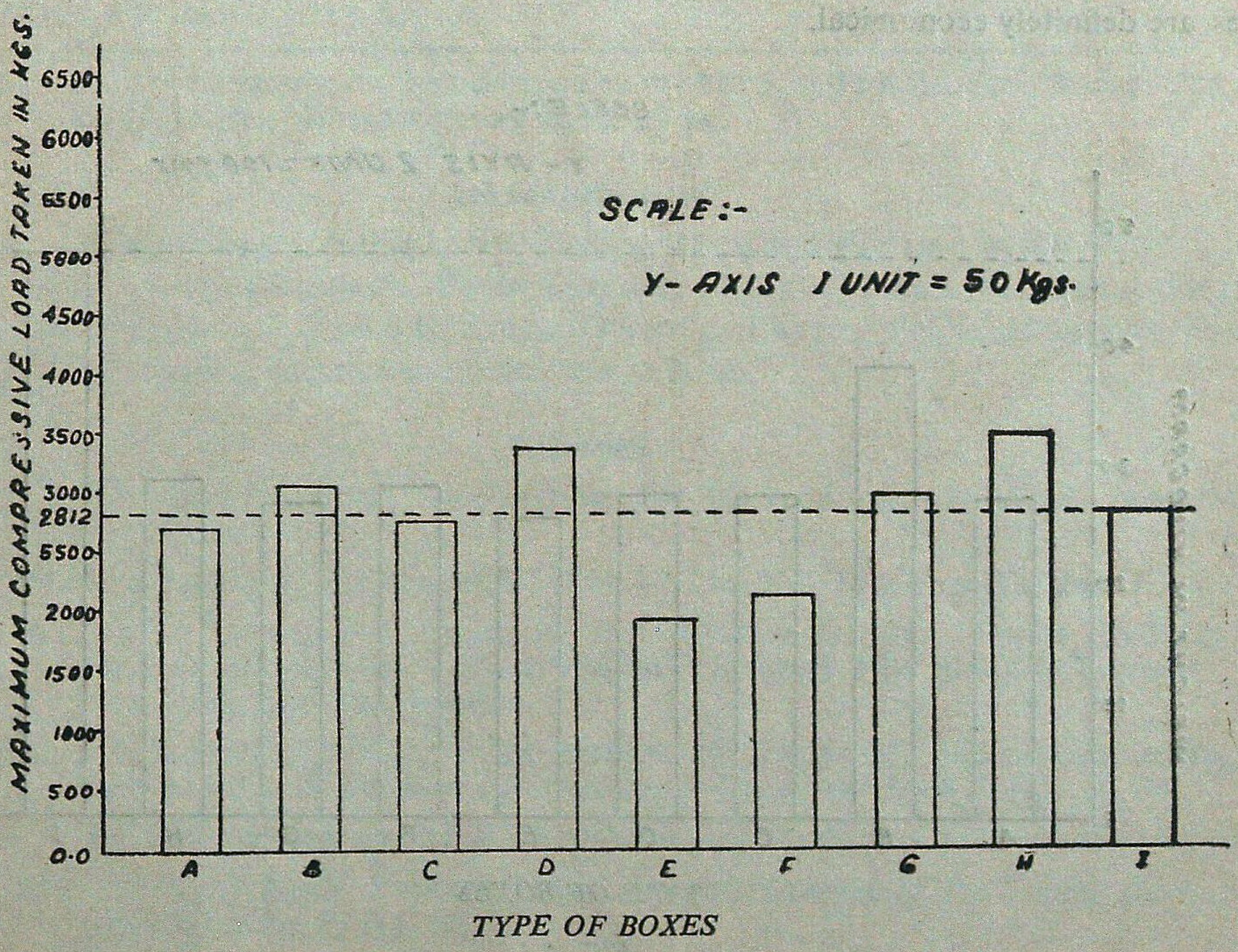

SCALE:-
Y-AXIS 1 UNIT = 50 Kgs.
MAXIMUM COMPRESSIVE LOAD TAKEN IN KGS.
6500
6000
5500
5000
4500
4000
3500
3000
2812
2500
2000
1500
1000
500
0.0
A
B
C
D
E
F
G
H
I
TYPE OF BOXES

FIG. 3

Effect of sheet materials on strength of the box

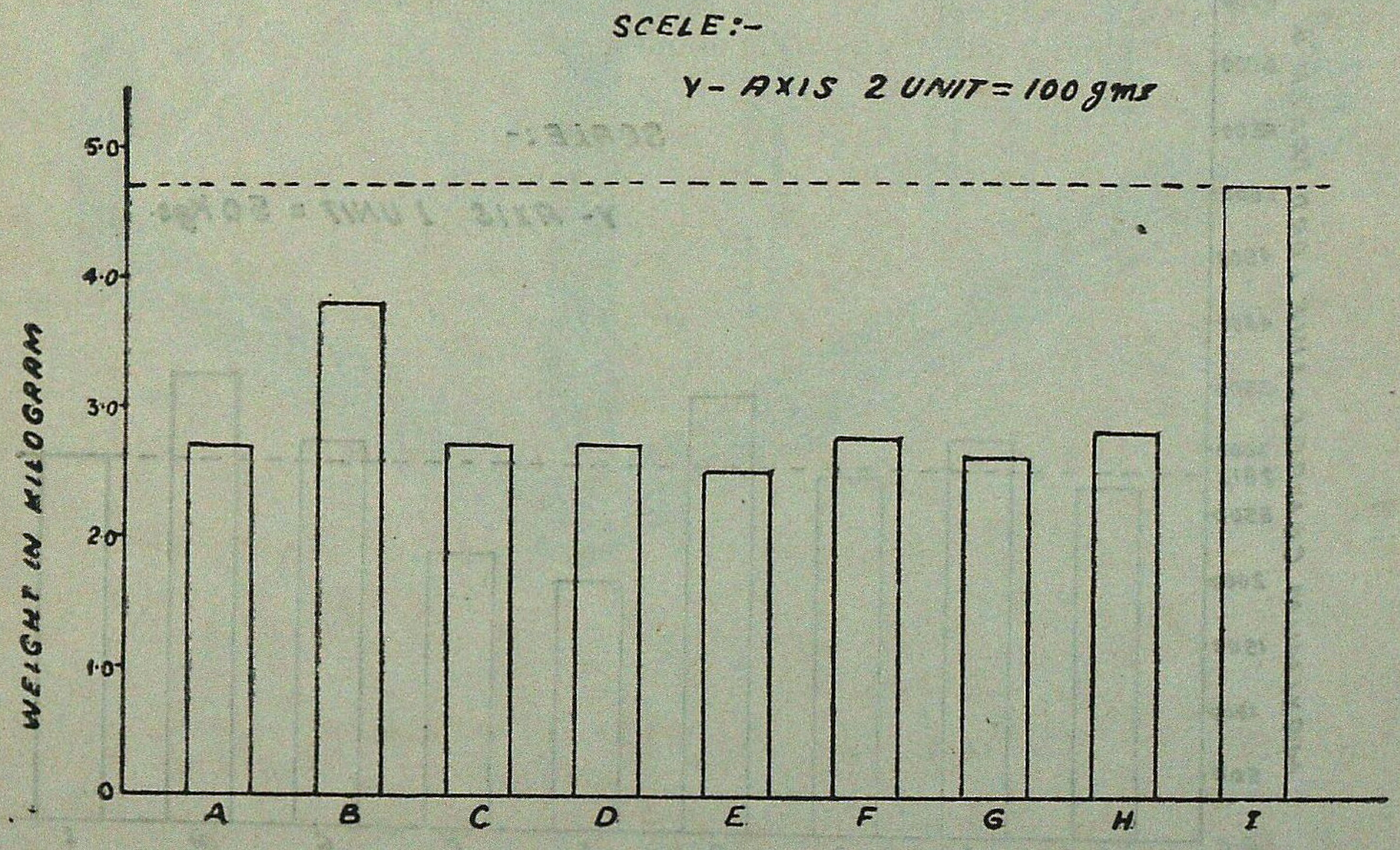
The analysis of variance of flat drop test data indicated the effect of different sheet materials to be statistically significant at 1% level of probability. Statistically the performance of boxes made from 3 mm th ck plywood & 3 mm thick toon veneer pasted with kraft paper on both the sides were better than the rest boxes. However, the performance of boxes made from rest sheet materials were statistically the same.

The variation observed with respect to top–bottom compression test on boxes from different sheet materials had no statistical significance at 5% level of probability. Therefore it can be inferred that the sheet matarials effect the capacity of box to withstand flat drop or rough handling rather than its capacity to withstand top-bottom compression or stacking load.

Economics of the alternate boxes

The cost of alternate boxes at Sl. No. 4 to 9 in the Table 1, is expected to be much less as compared to the plywood or hardboard boxes but may be a little costly with respect to conventional wooden boxes. If it is presumed that the timbers for making battens and veneers will be available at a reduced rates as it is available to the conventional wooden box manufacturers presently, then the cost is expected to become comparable to the wooden box.

The empty weight of these boxes is about half to that of wooden box of approximately the same size (Fig. 4), i.e these boxes use about half raw material than the wooden box. Therefore, its economy if viewed as the optimum utilisation of timber resouices these boxes are definitely economical.



TYPE OF BOXES

FIG 4

Table 1

Sl. No.	Material	Empty weight of box (kg)	Top-Bottom compression test Max. load (kg)	Flat drop test from a constant height of 1 m No. of drops before faliure
1.	Conventional wooden box (Simla style) of fir timber.	4.7	2812	11
2.	Plywood	2.7	2719	67
3.	Hard-board	3.8	3063	41
4.	Toon veneer pasted with Kraft paper (thickness of veneer is 3 mm approx.).	2.7	2769	48
5.	Mango veneer pasted with Kraft paper (thickness of veneer is 3mm approx.)	2.7	3370	33
6.	Mango veneer stitched with Kraft paper (thickness of veneer is 3 mm approx.).	2.8	3448	17
7.	Mango veneer pasted with News paper (thickness of veneer is 3 mm app.rox).	2.6	2970	13
8.	Toon veneer (3 loose veneer for a panel) (thickness of veneer is 1 mm. approx.).	2.5	1925	23
9.	Mango veneer (3 loose veneer for a panel) (thickness of veneer is 1 mm approx.).	2.7	2089	14

Note : Tests for compression was done on empty boxes and for flat drop on boxes having small wooden pieces weighting about 20 kg.

Acknowledgement

The authors record with thanks the kind assistance and guidance by Dr. S.R.D. Guha, Director, Forest Products Research, Forest Research Institute, Dehra Dun and cooperation and encouragement given by Shri S.N. Sanyal, Officer-in-Charge, Timber Mechanics Branch, Forest Research Institute, Dehra Dun, from time to time.

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SOME NOVEL TEA SUBSTITUTES FROM KASHMIR

A.K. KOUL J.L. KARIHALOO, IRSHAD AHMED; AND HARVINDER KIRN
Department of Biosciences, University of Jammu, Jammu

Introduction

In the past when communications were restricted, plants other than the conventional tea plant [*Camellia sinensis* Linn. (O. Kuntze)] were used for preparing the beverage. The presence of tannins for providing colour, and some stimulating compounds are the two requirements that a plant has to fulfil for providing a palatable drink. Quite a few wild plants have met these requirements and have thus been used for this purpose (Watt, 1889–1893; Dastur, 1951). Roots of *Fragaria vesca* Linn., for example, are widely used as a substitute of tea in the temperate Himalayas (Anonymous, 1956). Though the use of these wild plants has become highly restricted with the advent of speedier communications, yet they are used as a necessity and convention in the remote areas; and at times for curiosity alone.

The present communication brings to light three flowering plants from the Jammu and Kashmir State which for the first time have been recorded as tea substitutes. Photographs and semi-technical descriptions, alongwith the method of preparing the beverage from the text of the present communication.

Polygonum amplexicaule D. Don, (Fig. 1); (Family Polygonaceae)

It is an erect herb with perennial rootstock and slender 60 -80 cm long flowering stalks. Cordate leaves on the lower portions of the stem are stalked; while those on the upper portions are amplexicaul. Small, white or red flowers are borne in erect or drooping spikes. Leaves bear conspicuous, hyaline, tubular stipules which enclose the stem. Perianth of 5 petals, stamens 8, fruit a shining three angled nutlet.

It is a widely distributed plant in the temperate areas of the State above 1500 m. The rootstocks known as "Machran" in Kashmir and "Masloon" in Poonch, are the favourite tea substitute in the locality. On boiling, the rootstocks yield a rose-coloured beverage. Milk forms a part of the drink.

Polygonum amplexicaule growing in Kashmir contains 14.9% tannins (Wali *et al.*, 1969), and as such shows sufficient promise for use as a tanning agent (Sarin and Kapoor, 1962). The plant also constitutes an important fodder element (Anonymous, 1969).

Balanophora involucrata Hook. f. & Thoms., (Fig. 2); (Family Balanophoraceae)

A curious little parasitic angiosperm, it looks more like a mushroom than a flowering plant. *Balanophora involucrata* was first recorded from Sinthon in Kishtwar (Wafai and Singh, 1972).

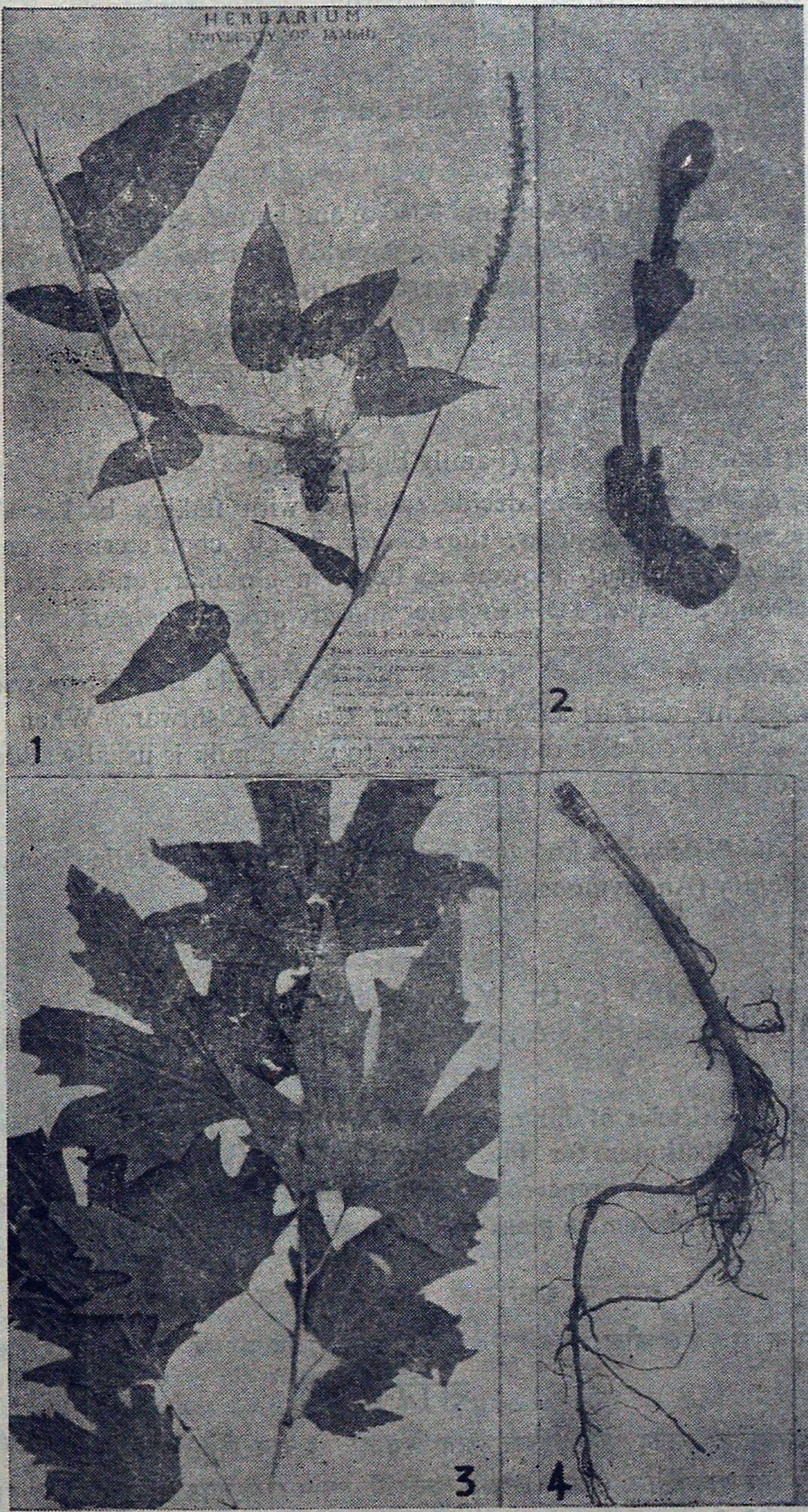

Fig. 1–4. 1. Flowering branch of *Polygonum amplexicaule* alongwith its rootstock, 2. A plant of *Balanophora involucrata*, 3–4. A twig (Fig. 3), and root portion (Fig. 4) of *Platanus orientalis*.

It is a brown root parasite with tuberous, warted rootstock. The 10-14 cm tall flowering stalk is the only portion which comes above ground. Almost at the middle of the stalk is present a ring of involucral scales which are fused almost to the middle. The flowering head is ovoid, consisting of minute unisexual (Wafai and Singh, 1972) or bisexual flowers.

Widely distributed in Poonch around 3040 m and known as "Mastani Booti", it is used by the Gujars as a tea substitute. On boiling it yields a strong decoction which resembles tea in colour. The odour of the beverage resembles that of *Glycyrrhiza glabra*. Very strong extracts of *Balanophora involucrata* have narcotic properties causing giddiness and acting as a strong sedative. Its local name—"Mastani Booti"—aptly refers to these properties of the plant.

Platanus orientalis Linn., (Fig. 3 & 4); (Family Platanaceae)

Plane or *Chinar* is a large deciduous tree with flaking bark. Very common in Kashmir and the neighbouring areas, the *Chinar* bears characteristic palmate leaves on massive and spreading branches. Flowers are borne in globular, unisexual, drooping heads; the heads themselves are clustered 2-3 together and are green in colour.

Locally known as "Boone", it is a majestic shade tree grown widely in Kashmir. The roots of this tree are used as substitutes for tea in Kishtwar. When boiled in water the roots yield a deep carmine red decoction to which milk is usually added to taste. The beverage is more or less tasteless and odourless.

The bark of *Platanus* is known to possess medicinal properties being used to prevent diarrhoea and dysentry (Anonymous, 1969).

Acknowledgements

Authors are thankful to Dr. Y.R. Malhotra for providing facilities. Financial assistance from I.C.A.R. and I.N.S.A., New Delhi is gratefully acknowledged.

SUMMARY

From the high altitudes of Jammu and Kashmir State three plants have been collected which are used as substitutes for the conventional tea plant—*Camellia sinensis* (Linn.) O. Kuntze. The beverage is prepared from the roots of *Polygonum amplexicaule* D. Don, and *Platanus orientalis* Linn.; and entire plants of *Balanophora involucrata* Hook. f. & Thoms.

चाय के कश्मीर से प्राप्त कुछ विलक्षण बदल

लेखक ए० के० कौल, जे० एस० करीहालू, इरशाद अहमद व हरविन्दर किर्न

सारांश

जम्मू व कश्मीर राज्य के अधिक ऊंचे स्थानों से तीन पौधे संग्रह किए गए हैं जिन्हें पारम्परिक पेय पादप चाय–कैमेलिया साइनेंसिस (लिन०) ओ० कुन्तज के स्थान पर उपयोग किया जाता है। यह पेय पोलिगनम एम्पलेक्षीकाउले डे० डान और प्लैटेनस ओरियंटलिस लिन० की जड़ों तथा बैलेनोफोरा इन्वोलुक्रेटा हुक० व थाम्स के पूरे पौधों से तैयार किया जाता है।

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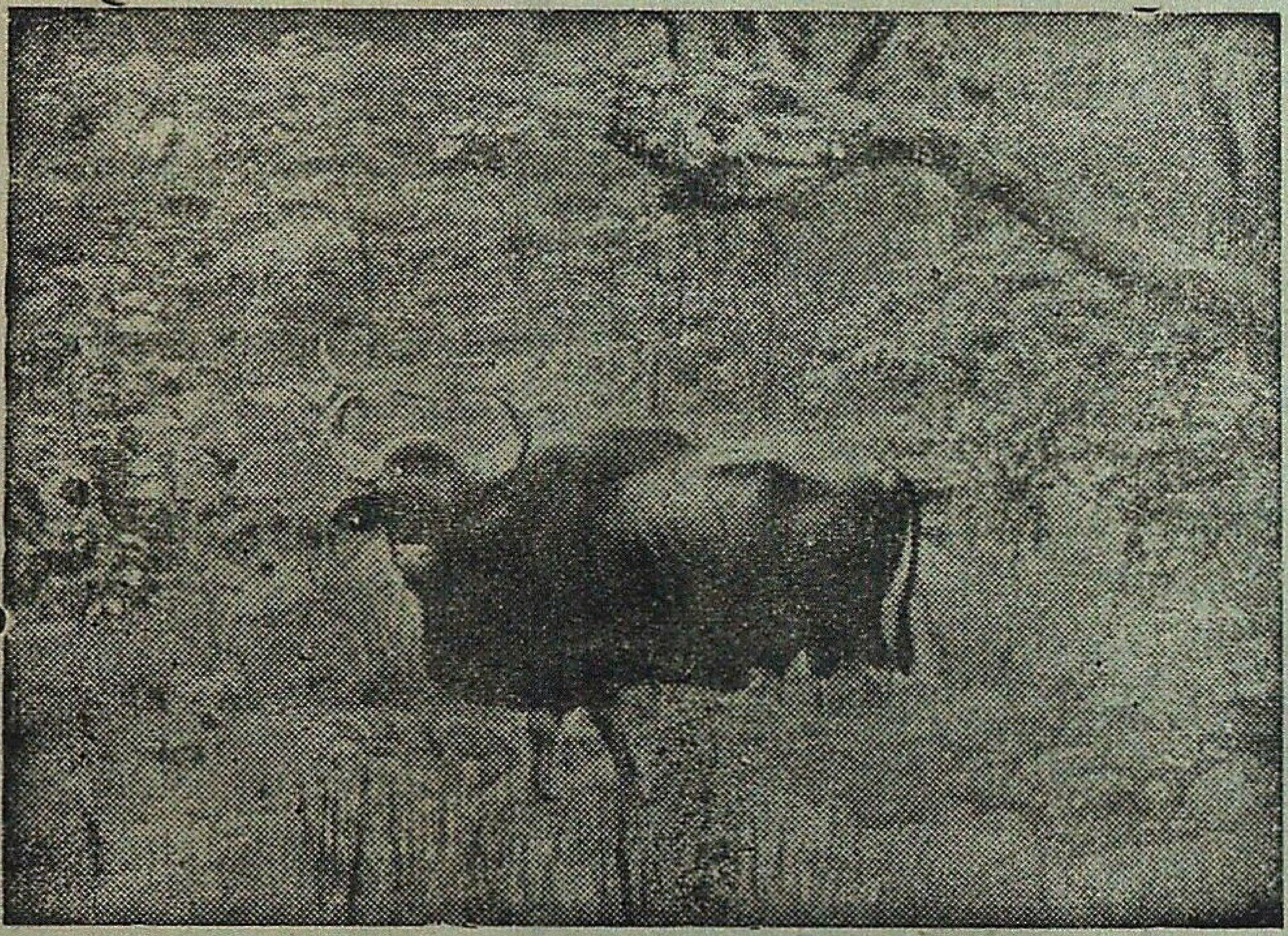
BANDIPUR GAME SANCTUARY—KARNATAKA STATE



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Contact : DISTRICT FOREST OFFICER, MYSORE

CERCOSPORA NEEDLE BLIGHT : A POTENTIAL THREAT TO INDIGENOUS PINES IN INDIA

SUJAN SINGH

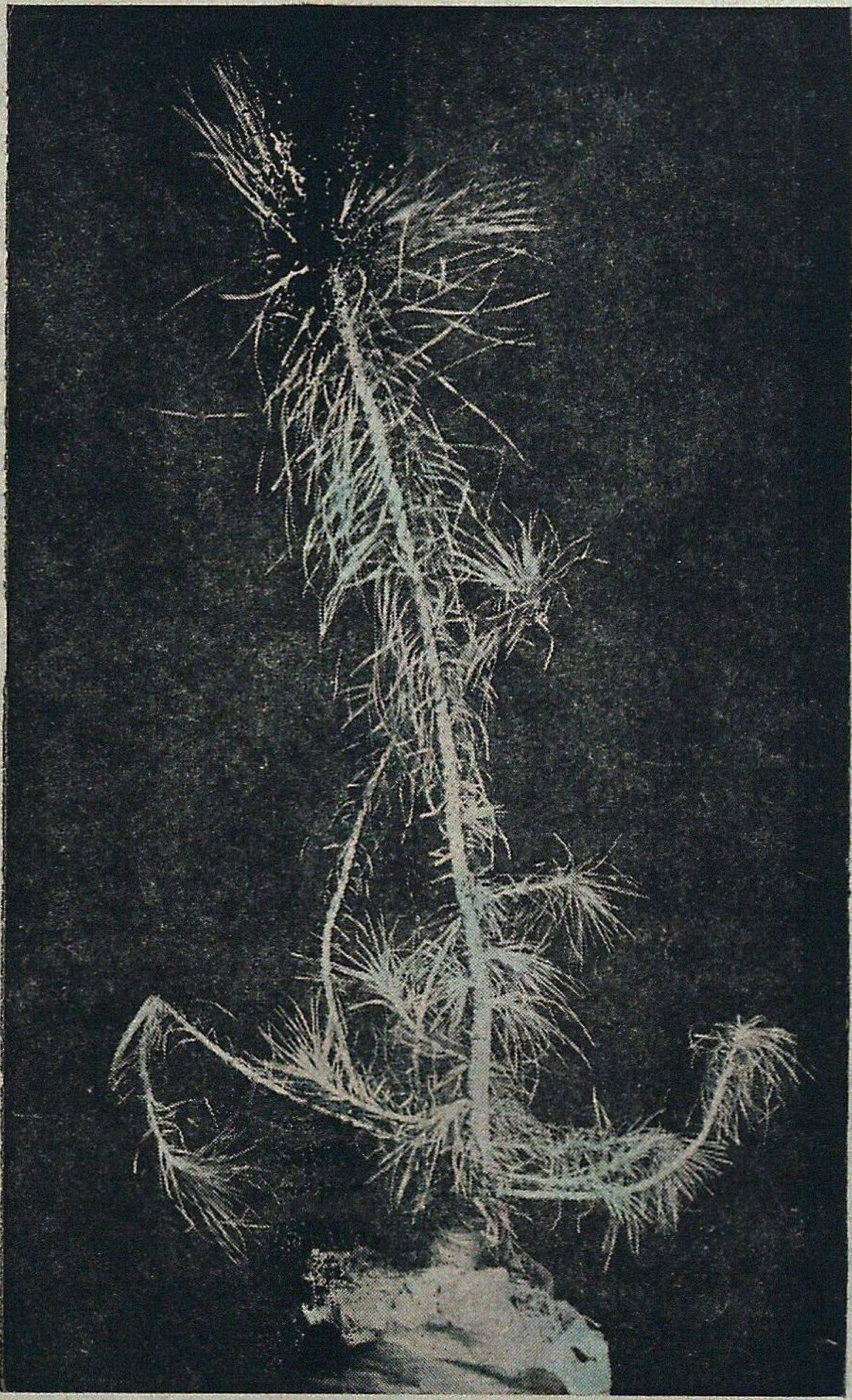
Senior Research Officer, Disease Insect Survey,
Forest Research Institute & Colleges, Dehra Dun

Cercospora needle blight of pines caused by *Cercoseptoria pini-densiflorae* (Hori et Nambu) Deighton (=*Cercospora pini-densiflorae* Hori et Nambu), a pathogen of exotic origin, was first recorded in India on *Pinus radiata* D. Don from Amarkantak during 1973 (Reddy and Pandey, 1973), Since then, *Cercospora* needle blight has been found to cause heavy mortality in seedlings of indigenous and exotic pines in various nurseries. The disease has been recorded from New Forest, Ranipur, Sat Narayan, Kalsi, Ranikhet and Lohaghat pine nurseries in Uttar Pradesh; Jagdalpur, Kurandi and Amarkantak pine nurseries in Madhya Pradesh; Koraput and Kalinga pine nurseries in Orissa and Araku and Maridumilli pine nurseries in Andhra Pradesh (Sujan Singh *et al.*, 1980). The pathogen probably occurs in nurseries of exotic pines in other areas also. *Pinus patula* Schlecht and Cham., *P. radiata*, *P. caribaea* Morelet, *P. echinata* Mill., *P. oocarpa* Schiede, *P. clausa* Vasey, *P. merkusii* Jungh. and de Vriese, *P. elliottii* Engelm., *P. tenuifolia* Benth., *P. greggii* Engelm., *P. pseudostrobus* Lindl. and *P. taeda* Linn. among exotic pines and *P. kesiya* Royle ex Gord., and *P. roxburghii* Sargent among indigenous pines were found infected by *Cercospora* needle disease in various nurseries. Elsewhere the fungus has been reported from Japan, China, Taiwan, Korea, West Malaysia, North Vietnam, Sri Lanka, Tanzania, Zambia, Rhodesia and Brazil (Gibson, 1979).

The symptoms of the disease in nurseries first appear as pale green lesions on needles which quickly turn yellow, then brown and finally grayish brown. Eventually, the whole needle may die and turn grayish with lines of minute sooty spots indicating clumps of conidiophores which bear conidia. The spread of the disease takes place through airborne conidia which are produced in large numbers on dead and diseased foliage (Sujan Singh and Gibson, 1981). Lower needles in the seedlings are first attacked. The disease then slowly spreads upwards. In severely attacked seedlings, only the growing shoot remains green while all the needles on the stem are killed by the disease (Pl. 1). Infected seedlings eventually succumb to the disease.

During recent field trips, it was observed that *P. wallichiana* A.B. Jackson and *P. roxburghii*, the two indigenous pines, planted in mixture or in the vicinity of exotic pine plantations or occurring naturally near exotic pine plantations were heavily attacked by *Cercospora* needle blight. On close examination it was found that the disease existed in the exotic pine plantations on primordial needles infected by the fungus at nursery stage and still attached to the stem of the seedlings. On *P. wallichiana*, the disease was recorded on 5 to 15 year old plants from Chandak (near Pithoragarh) and on upto 20 year old plants from Chakrata in Uttar Pradesh. On *P. roxburghii*, the disease was recorded on natural

Plate 1



Pinus roxburghii seedling : needles heavily attacked by *Cercoseptoria pini-densiflorae.*

regeneration in Ajehri, Simgarhi, Dharmgarh and Sassola and in plantations from Chandak (on 5–15 year old plants), Shillangi (on two year old plants) and Kalsi (on 2–10 year old plants) (all in Uttar Pradesh). The infection on both *P. wallichiana* and *P. roxburghii* starts from tips of needles in outer portion of the lower crown and then slowly spreads to the entire outer crown. The seedlings may succumb to attack of the disease when heavily infected while saplings and bigger plants generally look as if burnt by fire in the outer portions of the crown.

In plantations of exotic pines, *P. radiata* was found highly susceptible to *Cercospora* needle blight. The species has however been planted on experimental scale only. *P. oocarpa* was found defoliated by *Cercospora* needle blight in three year old plantation in Devarapalli (Andhra Pradesh). Among other species, *P. pseudostrobus* (12 year old), *P. patula* (4 year old) and *P. caribaea* (4 year old) suffered from a light attack of the disease in the needles of outer crown in a small plantation in New Forest. Elsewhere these and other species of exotic pines were found either free from attack of the disease or the diseased seedlings recoverd after the crop was established in plantations. *P. kesiya*, an indigenous pine, was found free from *Cercospora* needle blight in plantations raised outside its natural zone excepting a light attack of the disease in a small, four year old plantation in New Forest area.

From the limited observations, it is evident that both *P. wallichiana* and *P. roxburghii* are susceptible to *Cercospora* needle blight in nurseries, natural regeneration and plantations. Among exotic pines, all the four pines namely *P. caribaea*, *P. patula*, *P. elliottii* and *P. greggii* being raised on large scale possibly develop resistance against *C pini-densiflorae* in plantations. At present, the disease on indigenous pines is localized and confined to areas where exotic pines have been raised. The disease may cause extensive damage if it spreads to natural zones of both the pines. It is therefore, imperative to nip this evil in the bud and check its further spread in the country. For achieving this objective, the following measures are recommended.

1. A concerted effort should be made to eradicate *C. pini-densiflorae* from all the pine nurseries where it has been recorded. For this, all dead seedlings attacked by *Cercospora* should be collected and burnt. Infected needles of other seedlings which may be diseased but not yet dead, should be pruned, collected and burnt. After freeing the seedlings of their infected needles, these should be given a fungicidal spray with 0.6 per cent Dithane M 45 (Zinc, iron and manganese ethylene bisdithiocarbamate) upto the point of dripping to protect them from fresh attack of *Cercospora*.

2. Before removing the seedlings from infected nurseries for field planting these should be given a fungicidal treatment as stated in para 1 above.

3. Planting of exotic pines from *Cercospora* infected nurseries in mixture with *P. roxburghii* and *P. wallichiana* and in areas where the two indigenous pines occur naturally should be avoided.

4. After removing the existing stock from the infected pine nursery, the existing nursery site should be abandoned and a new site free from *Cercospora* blight should be selected.

5. Any new consignment of seeds should be freed from seed chaff and seeds should then be given treatment with a seed dressing fungicide like agrosan or cerasan before putting them for germination. This will eliminate the chances of any new introduction of *C. pini-densiflorae* which may be introduced on infected needle bits usually found mixed with seeds.

6. All the infected plants of *P. radiata* should be removed from plantations and disposed off. A strict vigilance should be kept on all exotic pine plantations and plantations of indigenous pines raised in vicinity of exotic pine plantations. If attack of *C. pini-densiflorae* is noticed in any of these plantations, control of the fungus by use of fungicides should be resorted to.

7. Strict internal quarantine should be enforced so that no seedlings infected by *C. pini-densiflorae* are moved form one nursery to another.

The fungus at present is localized to areas where exotic pines have been introduced. It can thus be eradicated if concerted effort is made by all the persons connected with raising of exotic pines. It may be difficult to control the fungus if it establishes itself in natural zones of *Pinus roxburghii* and *P. wallichiana*. It is therefore, the time that the fungus should be eradicated so that a potential threat to the two indigenous pines of India can be averted.

Acknowledgement

Grateful thanks are due to Dr. P.K. Sen-Sarma, Director, Biological Research and Mr. Pratap Singh, Officer-in-Charge, Disease Insect Survey Branch of Forest Research Institute, Dehra Dun for going through the manuscript and offering valuable suggestions.

SUMMARY

***Cercospora* needle blight hither-to reported on pine seedlings in nursery stage, is now recorded on two indigenous pines, *Pinus roxburghii* and *Pinus wallichiana* on natural regeneration and in plantations. All the four species of exotic pines namely *P. caribaea*, *P. patula*, *P. elliottii* and *P. greggii* which are being raised extensively in plantations were found to develop resistance against attack of *Cercospora* needle blight in plantations though they were severely attacked by the disease in nurseries. The pathogen is of exotic origin and is an inadvertent introduction into the country. It is still localized to areas where exotic pines have been raised. Measures are suggested to eradicate the causal fungus, *Cercoseptoria pini-densiflorae*, from the infected nurseries at this stage as such eradication may become difficult when the fungus establishes itself in natural zones of *P. roxburghii* and *P. wallichiana*.**

सेर्कोस्पोरा पत्ती अंगमारी—भारत में देशी चीड़ों के लिए संभावी खतरा

लेखक सुजान सिंह

सारांश

सेर्कोस्पोरा पत्ती अंगमारी रोग, जो अभी तक रोपणी अवस्था में चीड़ के पत्तों पर होता सूचित किया गया था, अब प्राकृतिक पुनर्जनन में और रोपवन में दो देशी चीड़ों पाइनस राक्सबर्घिआई और पाइनस वालिशियाना पर होता अभिलिखित किया गया है। विदेशी चीड़ों की चारों जातियां अर्थात् पा० कैरिबिया,

पा० *पैटुला*, पा० *इलियटिआई* और पा० *ग्रेगिआई*, जो रोपवनों में बहुत उगाई जा रही हैं, रोपवनों में सेर्कोस्पोरा पत्ती अंगमारी के आक्रमण से प्रतिरोध क्षमता प्राप्त करती हुई देखी गई, यद्यपि उनपर रोपणियों में इसका भारी आक्रमण हुआ। यह रोग रगुजन विदेश से आया है और असावधानीवश देश में आ गया है। यह अभी उन स्थानों में सीमित है जहां विदेशी चीड़ उगाए गए हैं। आक्रान्त रोपणियों में इसी अवस्था में रोगोत्पादक कवक, *सेर्कोसेप्टोरिया पाइनि–डेंसिफ्लोरी*, को दूर करने के उपाय सुझाए गए हैं, क्योंकि बाद में जब यह कवक पा० *राक्सबर्घिआई* और पा० *वालिशियाना* के प्राकृतिक क्षेत्रों में भलीभांति स्थापित हो जाएगा तो इसे दूर करना कठिन हो जाएगा।

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RESEARCH NOTE

ON THE GENUS *URGENIA* STEINHILL (LILIACEAE) IN INDIA

The papers on the revision of the genus *Urgenia* in India (Deb and Das Gupta, 1974, 1978) are interesting since the authors consider *U. govindappae* Boraiah and Khaleel to be a synonym of *U. indica* Kunth. They have based this on the bigger bulbs bearing linear leaves and the smaller bulbs with broader leaves. It is true that the smaller bulbs of *U indica* do have broader leaves when young. However, as the plants grow older the bulbs become very large resembling apples The bigger bulbs with linear leaves, or intermediate characters between the two extremes as reported by them are not observed in the specimens from the type locality of *U. govindappae* and also other areas like Ranganathittu, Srirangapattana where *U. govind ppae* has been collected. Further, these authors have not examined the type specimen, although they have studied the other specimens collected from type locality (sent by G. Boraiah); they have completely ignored the most important morphological characters like oval, elongated 5–6 cm long, 2–4 cm broad bulb and 20–30 cm long deeply grooved, thick, 0.5–1 cm broad leaves which distinguish *U. govindappae* from *U. indica.*

It has now to be pointed out that Deb and Das Gupta (*L.c.*) have not taken into consideration an important difference like two pairs of chromosomes with secondary constrictions in the chromosomes morphology of *U. govindappae* (Boraiah and Khaleel, 1970) which has been one of the main criteria for the creation of a separate species. Deb and Das Gupta (*L.c.*) have thus ignored a very significant cytological evidence adduced by Boraiah and Khaleel (*L.c.*) hence *Urgenia govindappae* cannot be merged with *U. indica.* Thus the morphological and cytological evidences warrant the separation of *U. govindappae* from *U. indica* as a distinct species.

Holotype collected by Boraiah and Khaleel in Lalbagh garden, Bangalore, India on 17.5.1968 has been transferred from the herbarium of the University of Agricultural Sciences, Bangalore under the number 601 A, to the Central National Herbarium, Howrah, India.

University of Agricultural Sciences,
Bangalore. 560 065 India

G. Boraiah

and

Eastern Montana College,
Department of Biology
Billings, Montana 59101
U.S.A.

Tasneem Fathima Khaleel

References

Deb, D.B. and Syamali Das Gupta (1978). Taxonomic notes on the tribe Scilleae (Liliaceae), The *Indian For.*, **104** (9) : 642–645.

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LETTERS TO THE EDITOR

(I)

To,

The Hony. Editor,
Indian Forester,
New Forest, Dehra Dun.

Sub :—**Lesser Florican**

Sir,

I am to inform you that a female lesser florican was captured on 25.1.1982 in Darwha Range of West Yavatmal Division. This bird was brought to Nagpur on 27.1.1982. The specimen was identified by the delegates of the Pakshi Mitra Sammelan and Dr. Ambedkar from Bombay Natural History Society on 31.1.1982. This bird was ringed on 31.1.1982 and was released on 2.2.1982 in the forests of Ganeshpur village in Darwha Range where it was captured. The details of the bird are as under :—

(i)	Length of the bill	...	13 mm
(ii)	Length of the tail	...	157 mm
(iii)	Length of the wings	...	176 mm
(iv)	Weight recorded on 31.1.82	...	365 grm
(v)	Ring No.	...	C 10974

Nagpur
9.2.1982.

Sd./- G.S. Kandey
Deputy Conservator of Forests,
Wildlife

(II)

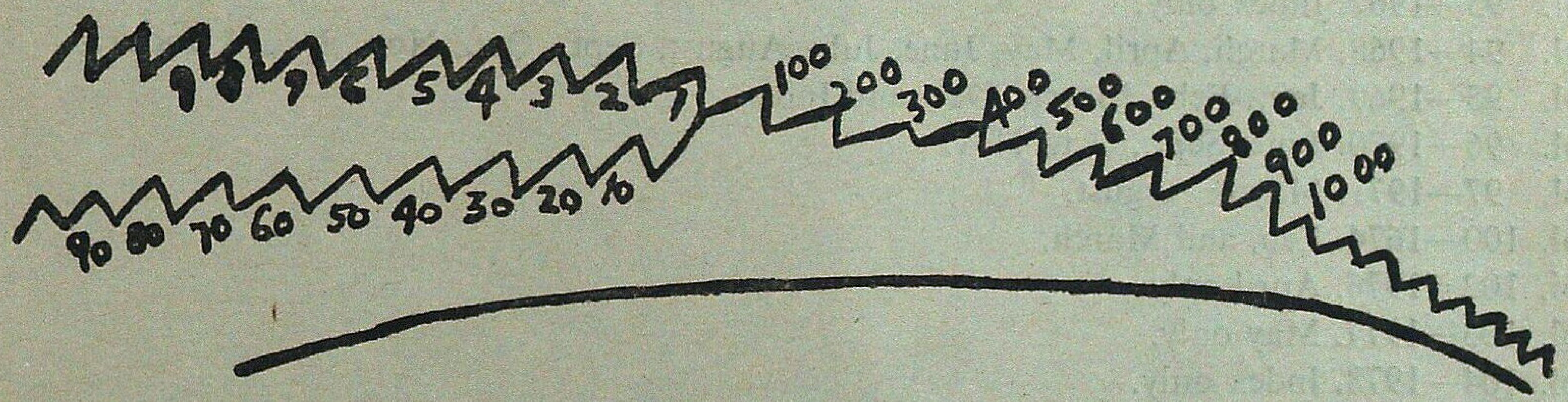
To,

The Hony. Editor,
Indian Forester,
New Forest, Dehra Dun.

Dear Sir,

With references to the article by Bob Bustard and Binod Choudhury (*Indian Forester* August, 1981) on marking crocodiles by clipping tail scutes, I have a few points to add. We have been using the clipping code system for ten years and confirm the view of the authors that it is an effective, permanent method; the same method has been in use in Papua New Guinea for about ten years It should be emphasized that the cut is to be made at the base of the scute as re-generation of half-cut scutes is often rapid in young, growing animals. A sterilized knife is not necessary; infection has not occurred in several thousand observed clippings.

The main point I would like to make for interested readers is that the numbering system for individual animal can be simply set up to account for almost any number of crocodiles by following the clipping code system used at the Madras Crocodile Bank and shown in the diagram below.



We use only the first nine double caudal scutes and upto ten of the singles to make combinations upto 1999. To go over this number there are several methods. For example adjacent scute numbers 1 and 2 can be clipped to denote 2000 and all numbers ending in 1 and 2 would thus be absent from the 2000 series.

Madras

13.2.1982

Sd./- Romulus Whitaker
Director,
Madras Snake Park Turst,
Guindy.

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ANDHRA PRADESH GAZETTE

The following postings and transfers are ordered :

1. Shri Rajesh Mittal, I.F.S., on completion of practical training in Warangal North Division, is posted as Divisional Forest Officer, Adilabad vice Shri A.P. Awasthi, I.F.S., transferred.

2. On transfer, Shri A.P. Awasthi, I.F.S., is posted as Deputy Conservator of Forests, Social Forestry, Nalgonda in the existing vacancy.

3. Shri J. Venkataiah, I.F.S., Divisional Forest Officer, Kothagudem, is transferred and posted as Dy. Conservator of Forests, Monitering Cell under Social Forestry in the office of the Chief Conservator of Forests in the existing vacancy.

4. Shri Chandra Manoharam, I.F.S., on completion of practical training in Mancherial Division is posted as Divisional Forest Officer, Kamareddy vice T.A. Dev Das, transferred.

5. Shri T.A. Dev Das, Divisional Forest Officer, Kamareddy on transfer is posted as Divisional Forest Officer, Logging Division, Khammam.

6. Shri P.V. Krishna Reddy, I.F.S., on completion of practical training in Eluru Division is posted as Divisional Forest Officer, Mahaboobnagar Division vice Shri C. Laxma Reddy transferred.

7. On transfer, Shri C. Laxma Reddy, Divisional Forest Officer, Mahaboobnagar is posted as Divisional Forest Officer, Logging Division, Kagaznagar.

8. Shri B. Soma Sekhar Reddy, I.F.S., on completion of practical training in Narsipatnam Division is posted as Divisional Forest Officer, S.C. Division Paderu vice Shri P. Gaddaiah transferred.

9. On transfer, Shri P. Gaddaiah, Divisional Forest Officer, S.C. Division, Paderu is posted as Divisional Forest Officer, Flying Squad Division, Guntur vice Shri R. Sree Ramulu transferred.

10. Shri R. Sree Ramulu, Divisional Forest Officer, Flying Squad Division, Guntur on transfer is posted as Divisional Forest Officer, Soical Forestry Division, Guntur in the existing vacancy.

11. Shri A.V. Joseph, I.F.S., on completion of practical training in Bhadrachalam South is posted as Divisional Forest Officer, Karimnagar East Division Vice Shri Lohit Reddy transferred.

12. On transfer Shri Lohit Reddy, Divisional Forest Officer, Karimnagar East Division is posted as Divisional Forest Officer, Kothagudem vice Shri J. Venkatayya, I.F.S., transferred.

13. Shri P. Narayana Reddy on return from leave is posted as Divisional Forest Officer, Logging Division, Nandyal.

14. Shri A.S. Rabbani, Sub-Divisional Forest Officer, Karimnagar East is transferred and posted as Divisional Forest Officer, Logging Division, Karimnagar.

15. Shri U. Venugopal, I.F.S., Divisional Forest Officer, Rajampet is transferred and posted as Divisional Forest Officer, Chittoor East vice Shri R.D. Reddy, I.F.S., transferred.

16. Shri R.D. Reddy, I.F.S., Divisional Forest Officer, Chittoor East Division on transfer is posted as Deputy Conservator of Forests, Social Forestry, Sangareddy in the existing vacancy.

17. Shri P.S. Sankar Reddy, Divisional Forest Officer, Flying Squad Red Sanders, Cuddapah is transferred and posted as Divisional Forest Officer, Rajampet vice Shri U. Venugopal, I.F.S., transferred.

18. Shri M. Narayan Rao, Asst. Conservator of Forests on return from leave is posted as Asstt. Conservator of Forests, Statistical Cell, Office of the Chief Conservator of Forests, vice Shri A. Satyanarayana Rao, Asstt. Conservator of Forests, transferred.

19. On transfer Shri A. Satyanarayana Rao, Asstt. Conservator of Forests, Statistical Cell, Office of the Chief Conservator of Forests, is posted as Divisional Forest Officer, Logging Division, Nirmal in the existing vacancy.

20. Shri G.V. Anjaneyulu, Sub-Divisional Forest Officer, Bhadrachalam North Division is transferred and posted as Divisional Forest Officer, Logging Division, Kothagudem.

21. Shri K.J.C. Westly, Sub-Divisional Forest Officer, Warangal North Division is transferred and posted as Divisional Forest Officer, Logging Division, Adilabad.

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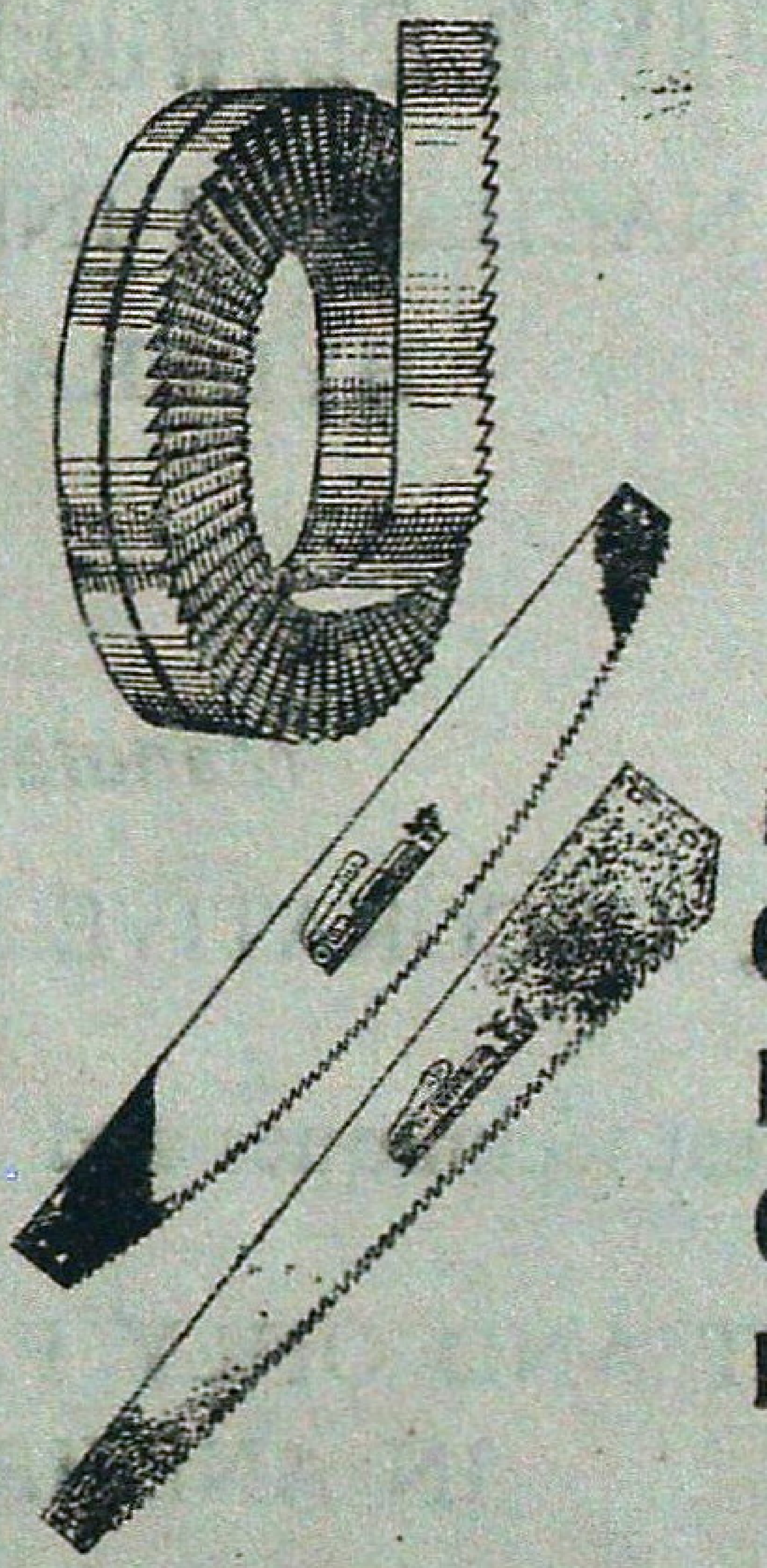

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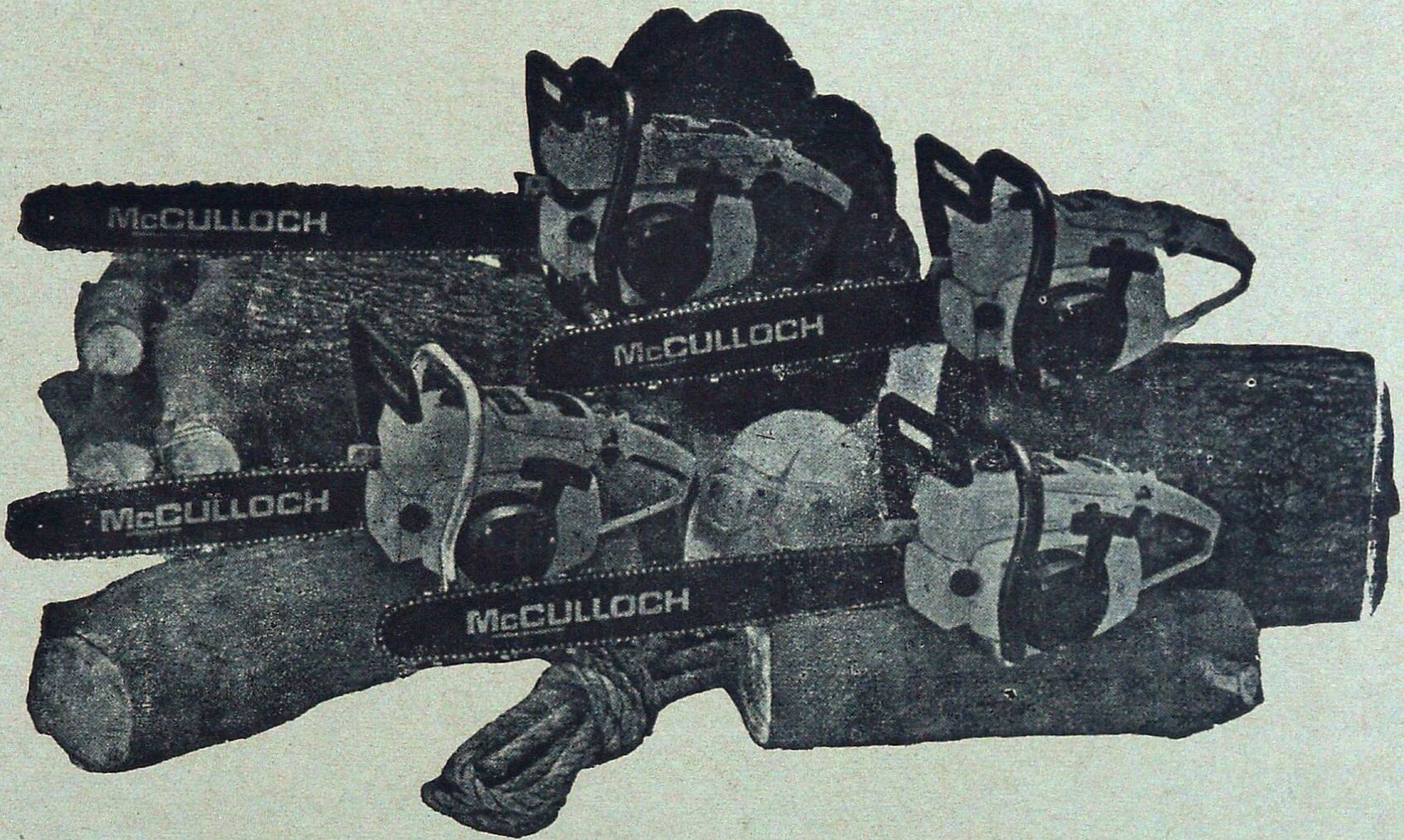

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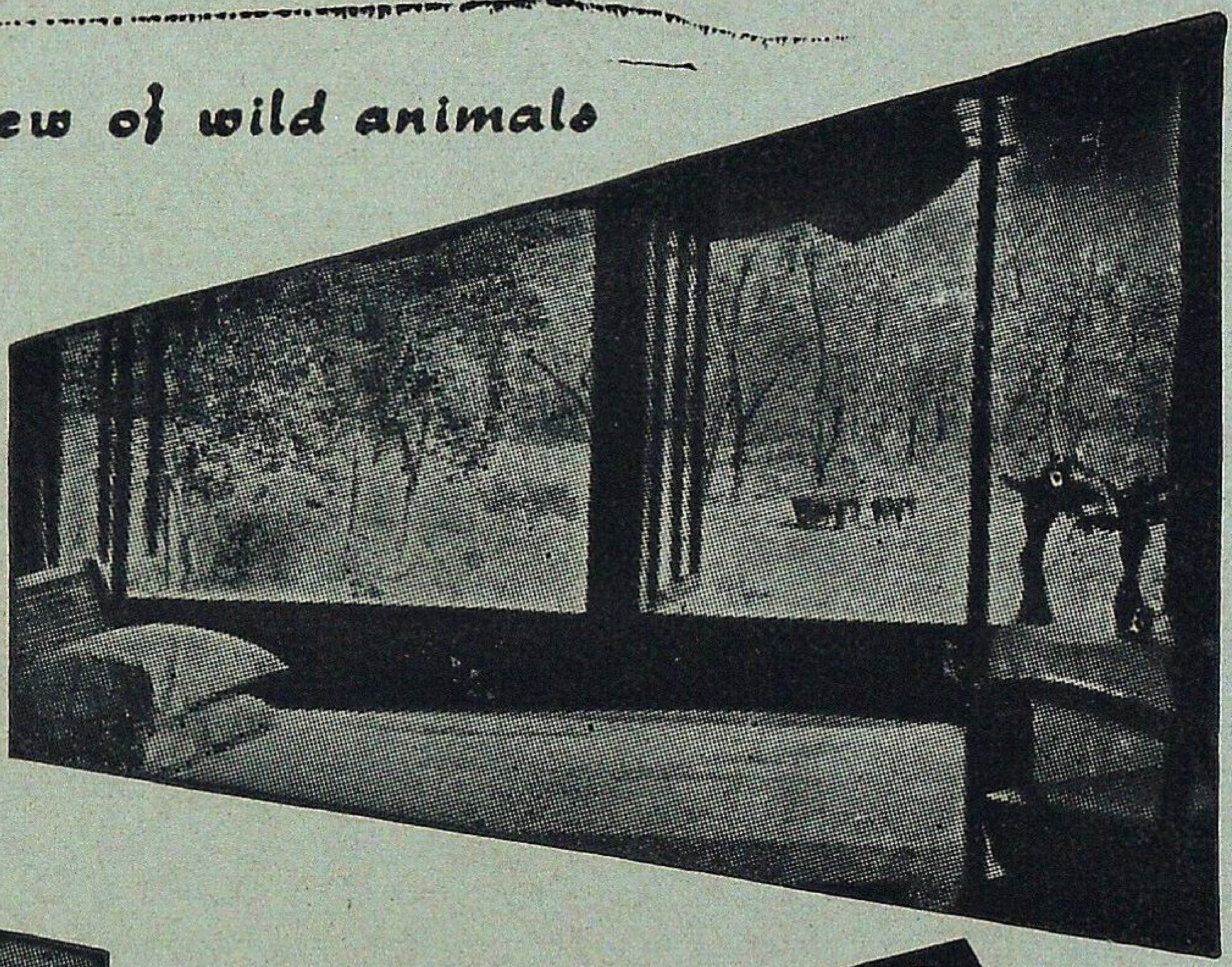

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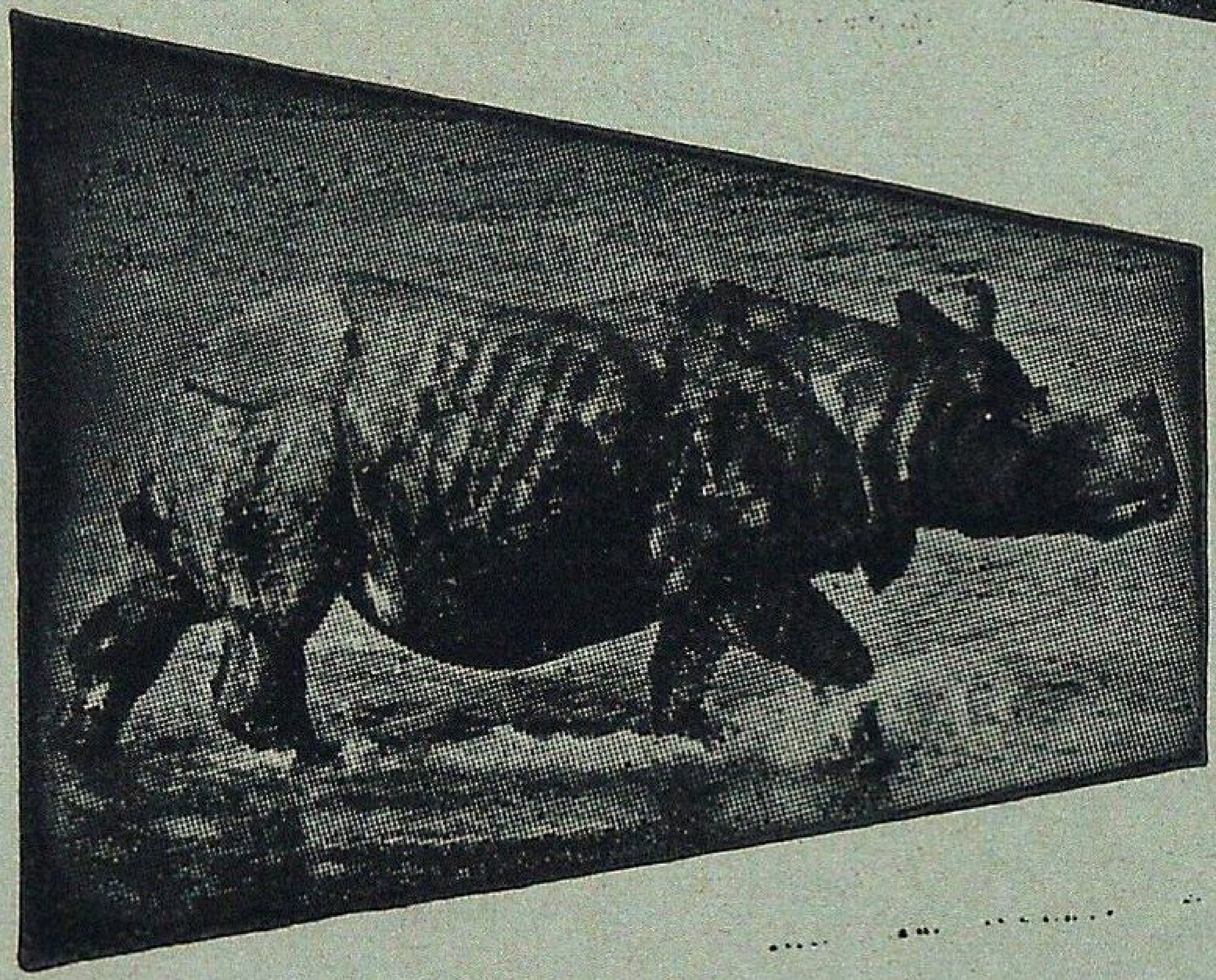

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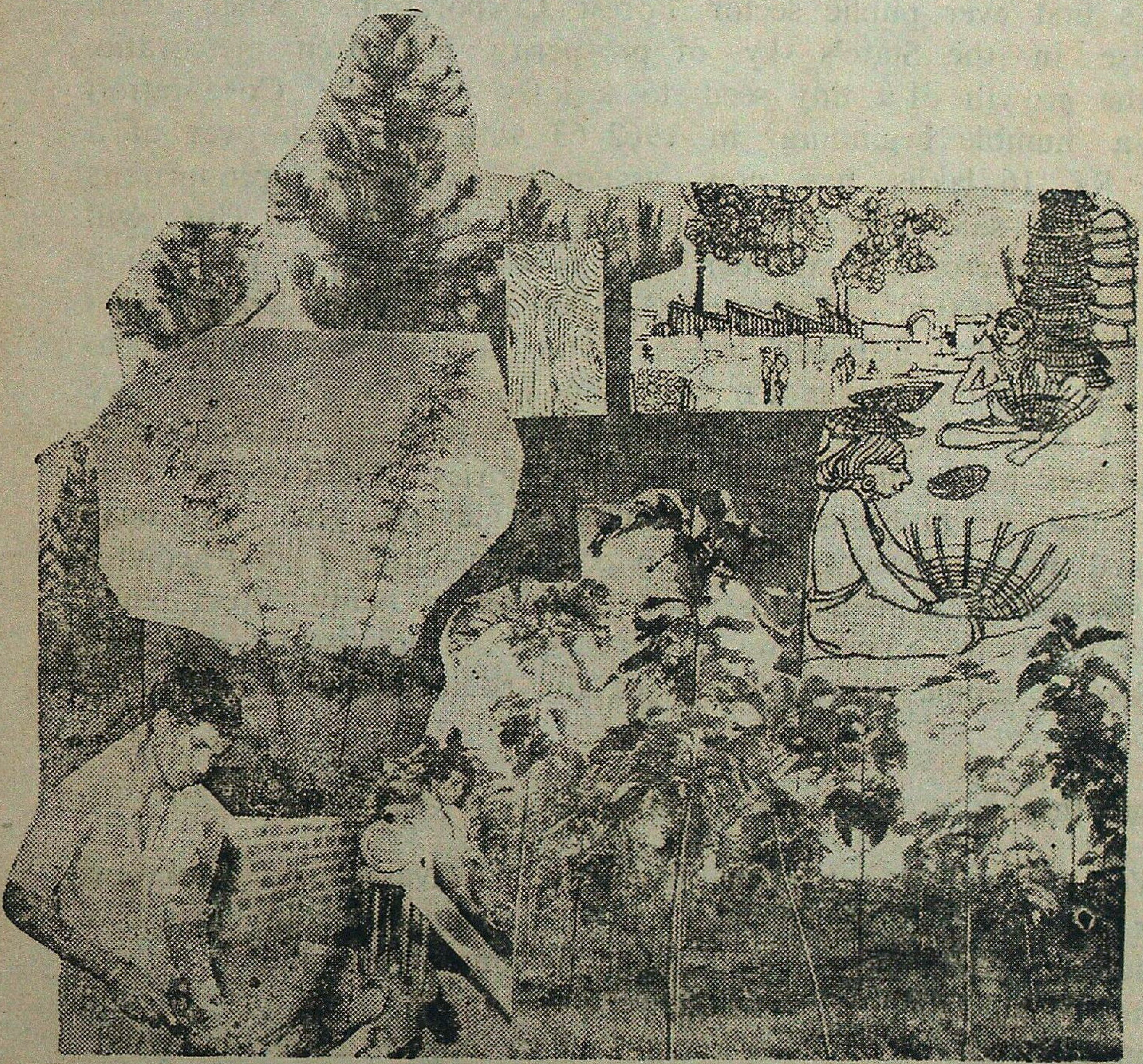

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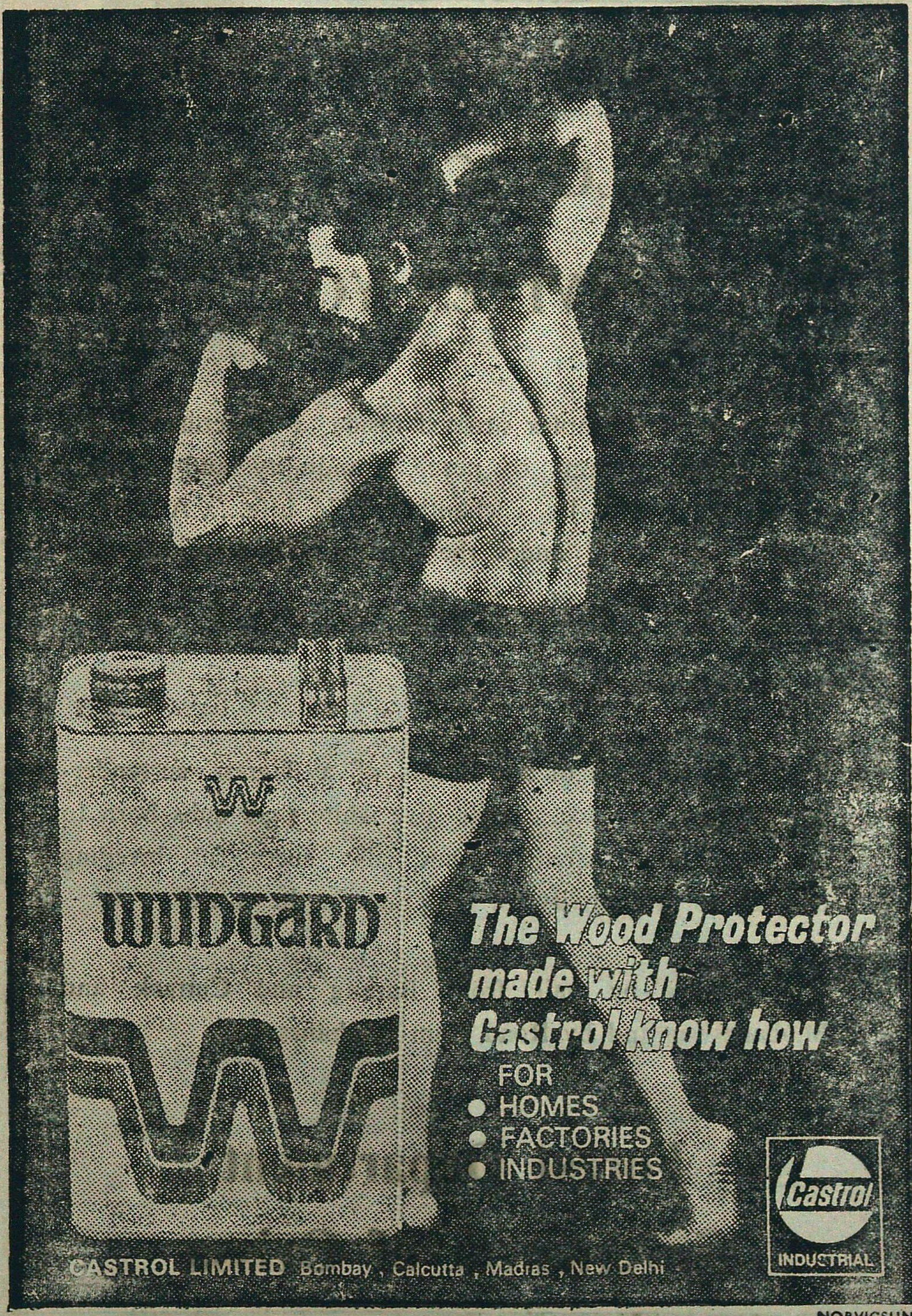
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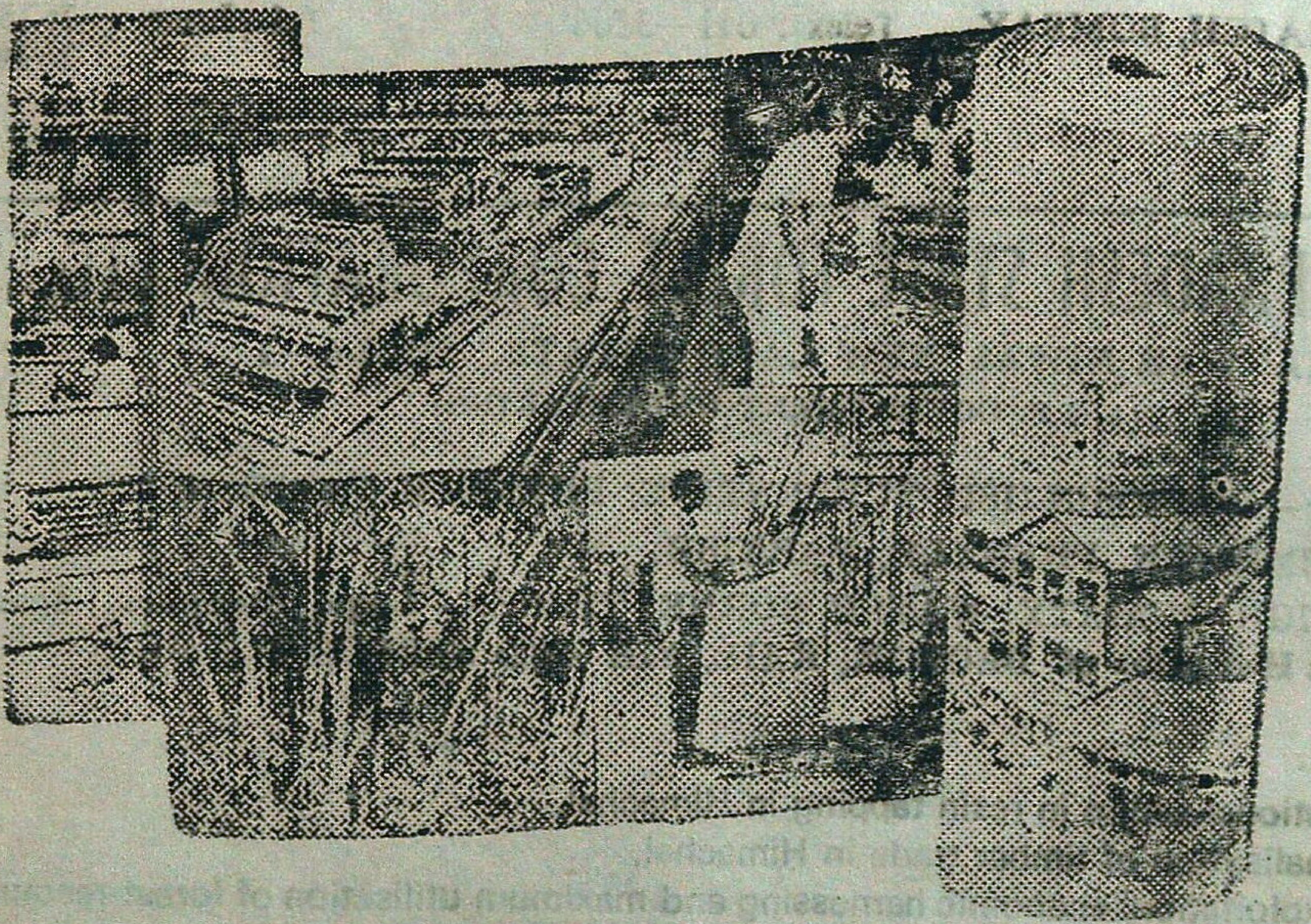

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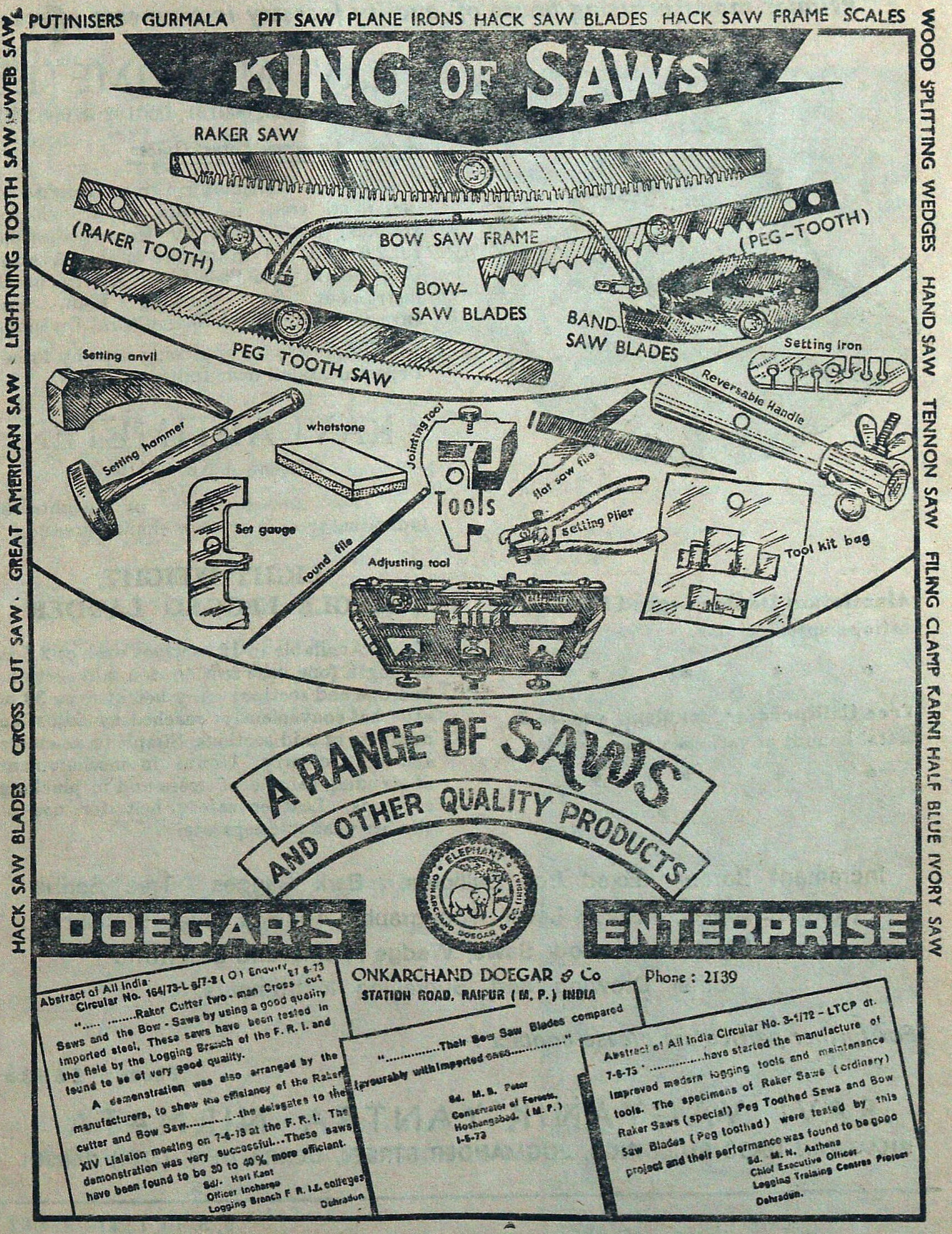
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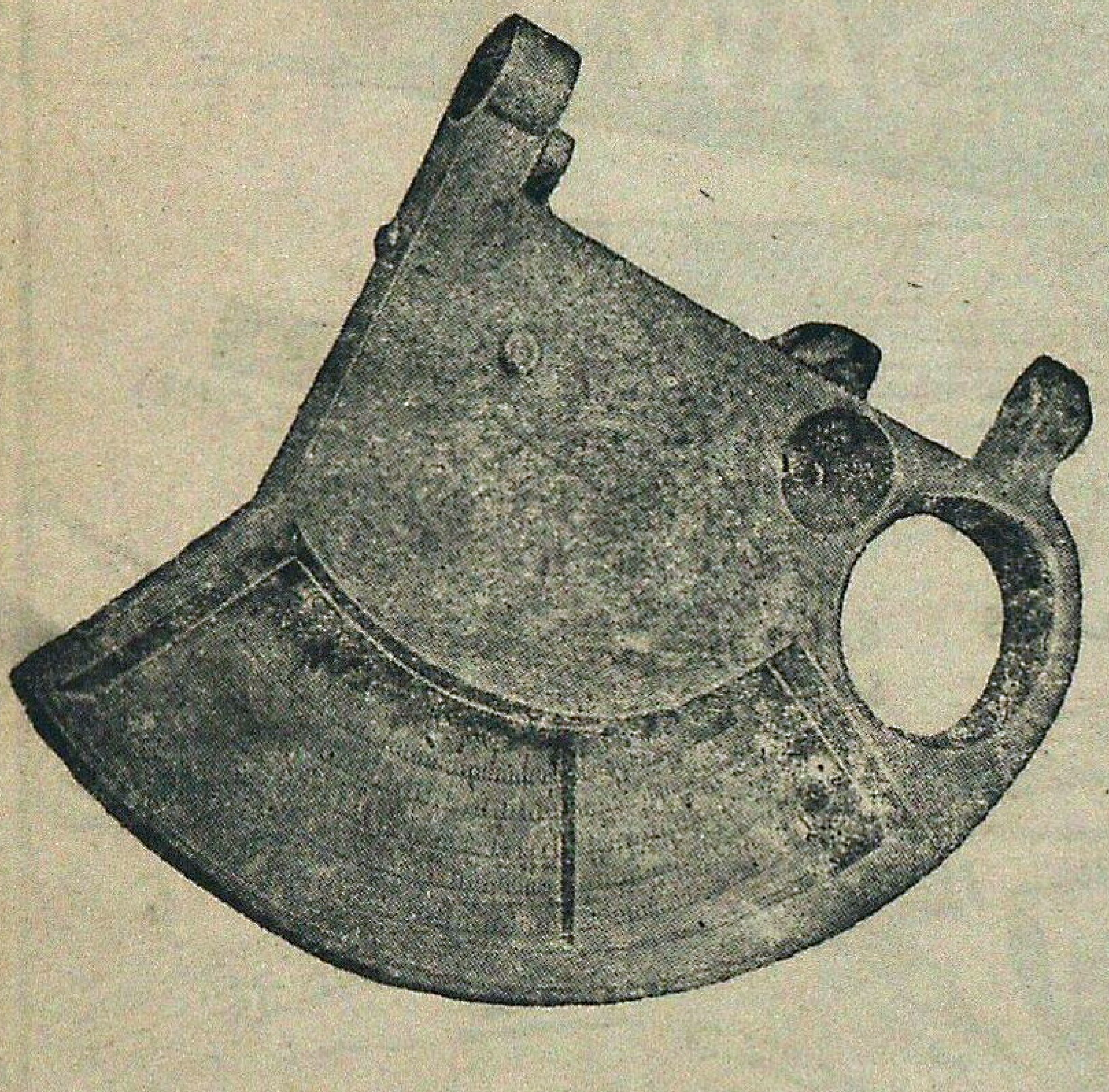

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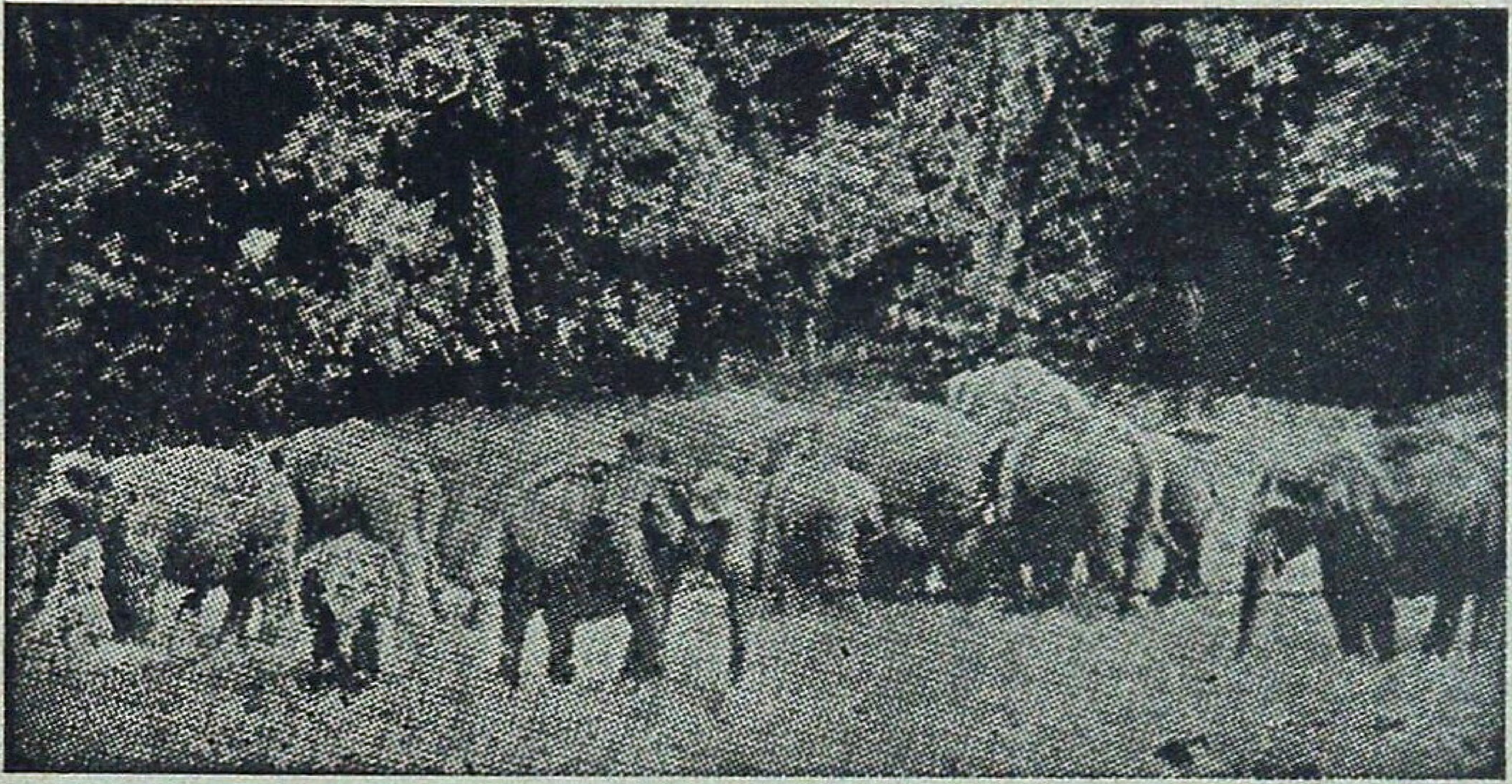

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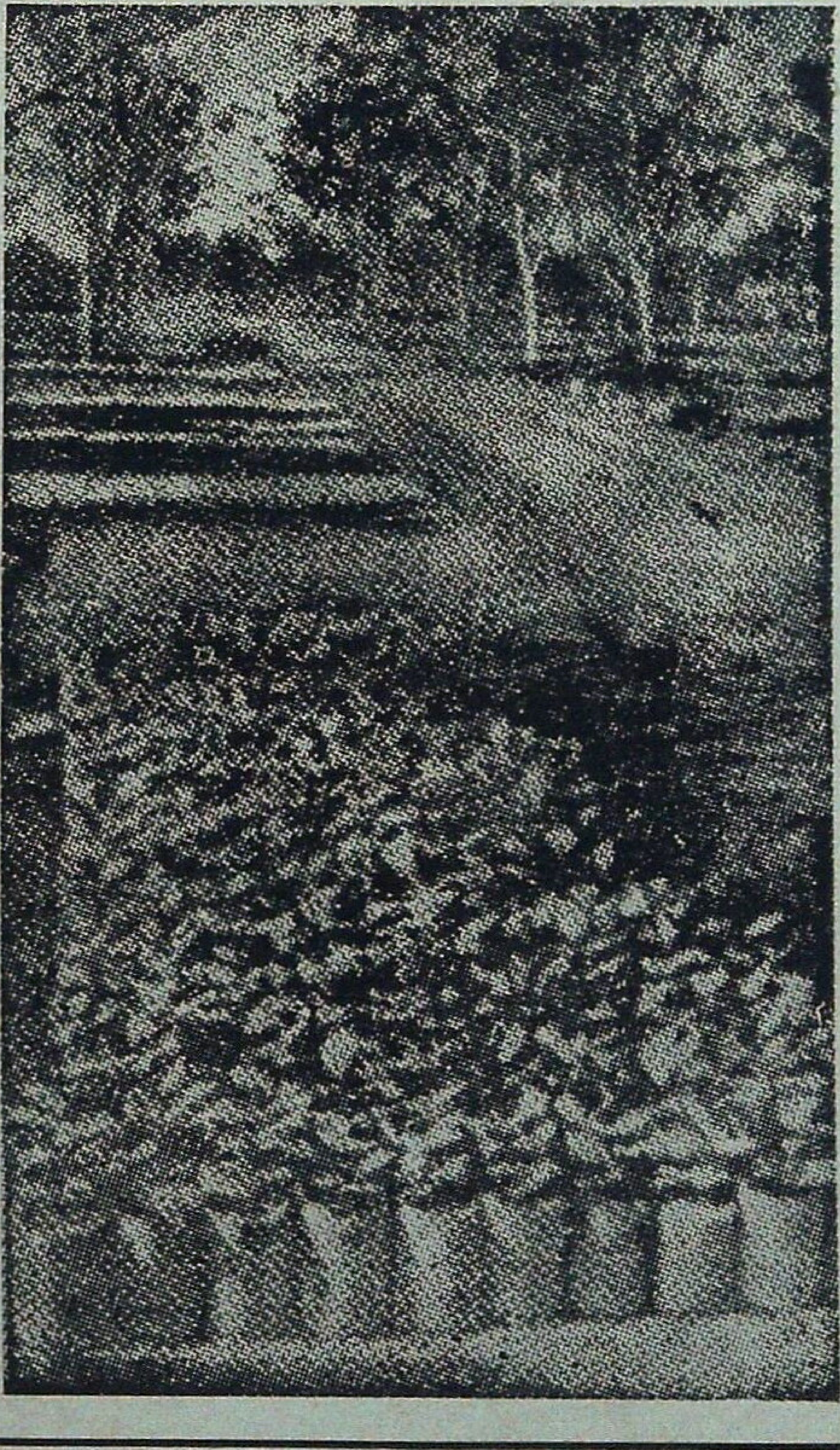

1/82—12/82

THE
INDIAN FORESTER

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WINDTHROW OF DEODAR, *CEDRUS DEODARA* AT DHANAULTI, YAMUNA FOREST DIVISION, U.P., IN FEBRUARY 1982, UPROOTED TREES HAD AN ATTACK OF ROOTROT *ARMILLARIALLA MELLEA*. Photo—Pratap Singh ... Front Cover

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